Atlas of

TECHNICS IN SURGERY

ATLAS

of

in

Illustrations by Alfred Feinberg and Robert Wabnitz

TECHNICS SURGERY

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WITH 62 contributing authors
DISCUSSING THE ILLUSTRATED SURGICAL TECHNICS

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To my wife
Birdie
and children
Pam
John
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Foreword

PREFACE

When the idea for the *Atlas of Technics in Surgery* was proposed, there were frequent discussions relative to the aims, the ideals, and the scope of such an Atlas and the best method of presentation From these discussions it was concluded that the Atlas should be prepared primarily for the practicing surgeon and the surgeon-in training, namely the surgical interne, the assistant resident, the resident, and the fellow in surgery

The author is wholly cognizant of the fact that one cannot learn either surgical technic or surgical judgment by simply referring to the illustrations in an Atlas In illustrations, the incisions never bleed and the clamps and ligatures on the cystic and superior thyroid arteries never unlock or slip off Furthermore, postoperative complications do not occur and there are no fatalities. Admittedly there is only one proper way to learn a sound surgical technic, and that is in the operation room under the guidance of a qualified and experienced practical surgeon. Similarly good surgical judgment is acquired only through extensive experience, sometimes bitter in the preoperative, the operative, and the postoperative care of the individual patient. Personal experience has been and always will be the most impressive teacher These basic facts cannot be overemphasized to either the surgical trainee or the inexperienced surgeon in practice. However it is believed that an Atlas of Surgery sufficiently detailed, may prove an ancillary aid to the reader in either assisting at or performing a particular operation. Furthermore, it is useful as a review of a technic for an operation that may be infrequently performed.

In the preparation of the Atlas the importance of having the medical artist present at each operation was stressed. It is only in this way that one may obtain in the illustrations anatomic realism and the creative interpretation of the artist. Only those operations that were witnessed by the medical artist are depicted. In some instances a particular operation was observed three or four times before satisfactory illustrations were obtained. The artist was instructed to depict carefully the anatomy of the region and the step-by-step technic as it was used in the operation It is believed that only in this way may a true portrayal of the technic of the operation be obtained. Furthermore each operation is profusely illustrated in detail to give a logical and progressive steplike pattern and to avoid the long "jumps" that so often prove confusing to the reader

The operative technics illustrated in the Atlas represent those that have proved the most satisfactory to the author There is no claim for originality in any of the operations demonstrated. In general, the technic of any one surgeon is an expression of the sum total of his experience obtained through teachers, preceptors, articles in current surgical journals, visitations to surgical clinics, and his own creative modifications The variations in technic employed by experienced surgeons are not unduly significant, provided there is no transgression of the tried and proved basic principles of sound surgical technic. To emphasize this fact each operation is discussed, not by the author but by a surgeon experienced in the performance of the particular operation under discussion. Each discusser was advised to stress, in particular points of disagreement and also to illustrate, if he so desired, the particular steps in operative technic that have proved to him the most satisfactory This was done to balance the opinion expressed by the author in the legends and illustrations and to serve as an aid to the reader in evaluating the proposed merits of a particular operative technic.

The Preface would be most incomplete if I did not acknowledge my indebtedness to George A. McDermott of Appleton-Century Crofts Inc., for his kind cooperation and incalculable aid in the preparation of the Atlas to Mr Alfred Feinberg, a consummate medical artist, for his sincere devotion, dependability and untiring efforts in his excellent portrayals of operative technics to Mr Robert Wabnitz for his contributions to the illustrations, particularly the anatomy of the diaphragm to Mother M. Alice, O.S.F., Administrator of St. Clare's Hospital for her many favors, kindnesses, and utmost cooperation, and to her successor Sister M Columcille, O.S F to Sister M Pauline, O.S F., Operation Room Supervisor for her generosity

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FOREWORD

The purpose of this volume is to present clearly and concisely a correlation of the anatomy physiology and understanding of pathology necessary to the technical "art of surgery" Such a book should be based on the cumulative experience of surgeon investigators and should include the more recent technical advances.

The author is eminently qualified to meet this challenge and has overcome the obvious difficulties He has produced a record of certain proved procedures valuable for quick reference for any experienced surgeon and especially stimulating to the thoughtful, inquiring mind in the formative phase of surgical training.

The illustrations are precise, beautifully executed, and presented in an orderly balanced fashion. The carefully edited legends accompanying the illustrations enhance the visual perfection of this work.

There can be no doubt that this Atlas is outstanding among the volumes portraying a workable anatomic-surgical approach to the practical problems of clinical surgery

JAMES M WINFIELD

Atlas of

TECHNICS IN SURGERY

INTRODUCTION

JOHN H MULHOLLAND

THERE ARE MANY methods to help a student learn *about* technical operative surgery the only way he can learn to *perform* operations is by doing them The creation of a complete surgeon is much more a matter of the development of thought processes than it is training in manual dexterity Any help in the whole process must provide for the thinking element in a primary way Offhand, it is difficult to picture how this requirement is met in a book illustrating operative technic, yet Dr Madden has done so in this book.

The ideal author of such a work would be either an artist who is a surgeon, or a surgeon who is an artist. No such fortunate combination in one individual has come forth. The closest analogous person was the anatomist and artist combined in Leonardo When an artist attempts to portray an operation without the thought processes of the surgeon, the result may be fine art but runs the risk of being untrue. Conversely with the surgeon who sketches or draws his operations, the result is apt to be intelligible only to him.

The training of a medical artist, like the training of a surgeon, is long and arduous. Alfred Feinberg is a recognized master in this field, as Dr Madden is in his. Their joint venture in this book is a happy one. Each must have striven by long conferences and exchange of ideas to acquire some of the viewpoint and skill of the other Brödel has written "A medical artist s eye should not work merely like a camera, it should digest the object and bring out the features which justify the task of picturing the case, without, of course neglecting the realistic and truthful characteristics"

Severe limitations are imposed on the surgeon by this method. He must transmit to the reader highly focused technical methods which he knows full well are individualistic. Steps he takes are directed toward an objective which may be achieved by different instruments, by different exposure and perhaps even by different attitudes. His depictions are then subject to minor and superficial criticisms which do not consider the objectives Many of the illustrations of Dr Madden s methods will almost certainly provoke the reaction "I do that differently" This is the price paid for completeness and definitiveness in the drawings. Such a reaction is on deeper thought a good lesson learned, particularly if both Dr Madden and the reading student are referring to an operative maneuver as important as exposing the right hepatic artery in the early stages of a cholecystectomy The point is that the artery is exposed.

The profit to a student reading this book is gained from what passes through his mind as he looks at the picture. The more profound the student, the greater the profit. Previous operative training, study of disease, experience, and intelligence contribute to the value of his thoughts. A number of factors combine to produce an idea which is only aroused by the picture.

The real test of the excellence of an illustration of operative technic is how such an illustration would stand without explanatory text. It would seem that the perfect drawing would require no text. Certainly an experienced surgeon, studying a good illustration, could compose an explanatory text of his own. Such a book as this, however is for students at all levels of learning. For beginners to study the illustrated steps of an operation which they will subsequently be observing for the first time, an explanatory text is essential.

Another good feature of the book is that all the operations were performed by one surgeon in the presence of the artist making his sketches. Sketches drawn under such circumstances are the result not only of what the artist sees, but also of what he knows about the surgeon s plan and method for carrying out that plan. The final drawing is completed after a joint review of the sketches by both artist and surgeon. The book s unity of purpose precludes an encyclopedic presentation

allergy particularly to any drug or medication, including antibiotics. This should be followed by a careful system review asking questions with regard to the central nervous system —including organs of special sense, respiratory tract, cardiovascular system, gastrointestinal tract system, genitourinary system—and a brief neuropsychiatric review. A menstrual history should be included for all adult female patients.

Physical examination, too often superficial on surgical services and confined to the immediate surgical lesion, should be sufficiently complete in detail to confirm the medical history and to evaluate the status of major systems. The anesthesiologist should never be the first individual to take the patient's blood pressure. A statement with regard to apparent age, sex, general appearance, and state of nutrition should be included. Do not forget that the ophthalmoscope gives ready access to the evaluation of the degree of arteriosclerosis which a patient has and that a rough approximation of the efficiency of the cardiovascular and respiratory systems can be obtained by the simple process of walking up a flight of stairs with the patient. It takes only a few minutes to check the Achilles, patellar tendon, and Babinski's reflexes of any patient; these should be recorded. A rectal examination should be made and recorded for all patients, and a pelvic examination should be made and recorded for all female patients except virginal ones.

The history taking and the examinations are time-consuming and in hospitals are usually assigned to the intern or to the junior assistant resident. The early development of a *systematic method* of taking a history and of doing a physical examination will not only greatly facilitate doing them but will also prevent overlooking occasional highly important findings.

BASIC LABORATORY DATA

No patient should go to the operating room for elective surgery without there being *recorded in the chart and observed by the responsible surgical team* at least:

1. A routine urinalysis, including microscopic analysis and determination of albumin and glucose. The specific gravity of the casually voided specimen is of doubtful significance. Remember that in female patients the microscopic examination of urine is of significant value only on a catheterized specimen.

2. A complete blood count which should include at least a hemoglobin determination, a total white cell count, and a statement concerning the apparent normality of distribution of platelets.

3. An x ray or roentgenogram of the chest, or a documented chest film that was made within the previous six months without interval respiratory history.

In addition, elderly patients should have determinations of the fasting blood sugar and a BUN or NPN made, and if there is any suspicion of cardiac history, an electrocardiograph baseline should be taken. Debilitated patients with recent weight loss, many of whom are likely to have cancer, should also have the total serum protein determined and one or two basic liver function tests. In patients with emphysema, asthma, partial obstruction of the airway, pulmonary infection, or atelectasis, the baseline CO_2 and chloride of the plasma should be determined, and if possible a blood pH should be obtained, in order to assess the degree of compensation for the respiratory acidosis that exists in these conditions.

BLOOD TRANSFUSIONS AND BLOOD REPLACEMENT

While the hemoglobin and hematocrit are likely to be fairly good indices of the circulating blood volume and red cell mass in the otherwise healthy patient, certain types of surgical patients are likely to have a diminished blood volume which is *not necessarily reflected* in a change in hemoglobin and hematocrit. This is particularly true if the patient is simultaneously deficient in circulating blood and dehydrated. Notoriously likely to have diminished blood volumes are patients with cancer, particularly cancer of the gastrointestinal tract, patients who have had chronic bleeding, as seen with uterine fibroids and particularly with ulcerative colitis, and patients with chronic infection of any sort, particularly if it is sufficient to give them a low grade fever. This phenomenon, sometimes designated as "chronic shock," was first described by Clark and Lyons (1) and has since become generally recognized among surgeons. Patients whose blood volume is not restored before surgery are likely to become hypotensive under anesthesia and will tolerate any surgical procedure very poorly. Blood volume technics involving the use of either the Evan's blue dye or radio-

active iodinated serum albumin are widely available and should be used when indicated (2, 3 4). A rule of thumb method of assessment is to give the patient with a suspected deficit a 500 ml. blood transfusion, *wait 24 hours,* then determine the hematocrit and compare it with a baseline hematocrit. If the hematocrit is low initially and only a one or two percentage point rise occurs with a 500 ml transfusion, give another 500 ml., wait 24 hours, and repeat the hematocrit evaluations When a 500 ml. transfusion in a patient who is not dehydrated produces a rise of the hematocrit to a normal range with a jump of three to five percentage points 24 hours after the transfusion is given one may assume that the cardiovascular system has its normal volume of blood.

In the patient who is acutely injured or who has just had a major hemorrhage, the red blood count and hematocrit will be deceptive. It takes one or two hours for the process of hemodilution to begin, and 24 hours for it to be complete following a loss of blood. Remember that patients with multiple fractures and crushing injuries, though they may not have lost blood externally will lose large volumes of blood into the site of injury and thus effectively deplete their blood volume. The best replacement is of course, whole blood. The next best is probably plasma In emergencies dextran or polyvinylpyrrolidone (P V.P) may be used. Remember to *take blood for cross matching before starting either dextran or P V P* because both interfere seriously with crossmatching technics. A useful rule of thumb to remember in the patient acutely injured or suffering hemorrhage is that it takes approximately a 15 per cent loss of circulating blood volume to drop the systolic blood pressure to *100* in a normotensive patient. A 25 per cent loss of circulating blood volume will result in a systolic pressure of about 80 If the systolic blood pressure is 60 or less, one can assume that about *30 to 40 per cent* of the circulating volume has been lost. Since the blood volume averages about 8.5 per cent of the body weight of the normal adult, this means a loss of the order of 1,000 ml to drop the systolic pressure to 100 mm., of 1,500 ml. to drop it to 80 mm., and of over 2,000 ml. to drop it below 60 mm of mercury Although in some cases 500 ml. of blood by transfusion may serve temporarily to raise the systolic blood pressure, this amount is inadequate to relieve the marked peripheral vasoconstriction and renal vasoconstriction which exist. Accordingly 1,000 ml. or more of whole blood should be given initially when the adult patient is suffering from acute trauma or hemorrhage and has a systolic blood pressure of 80 mm. of mercury

DEHYDRATION AND ELECTROLYTE LOSS OR IMBALANCE

Dehydration results when the patient is unable to take an adequate amount of water or when he loses an excessive amount through vomiting, diarrhea, and sweating, either alone or in combination Almost invariably the dehydrated patient has some degree of electrolyte imbalance, for the dehydration is most often the result of malfunction of the gastrointestinal tract. Dehydration due to pure water loss is seen in surgical patients only in the event of obstruction of the esophagus and inability to swallow or in the rare event of a patient with obstruction of the gastrointestinal tract who is unable to vomit. Sometimes acute water loss dehydration is seen in the postoperative period in patients who receive an inadequate parenteral replacement of fluid. Usually however water is lost with electrolytes from the gastrointestinal tract in either vomitus or diarrhea or both. Relatively pure electrolyte loss with the development of the "low salt syndrome" is sometimes seen in patients with marked diarrhea who because of thirst take large amounts of water by mouth but who do not replace the lost electrolytes The usual picture is a mixed dehydration consisting of both water loss and electrolyte loss, and this is the type which has been demonstrated to be the most dangerous (5 6). In assessing dehydration, a history if it can be obtained, is most important. How long has the patient failed to take in fluids by mouth? How long has the patient been vomiting or had diarrhea? What, if anything, has he been able to take in between episodes of vomiting? Remembering the total oral intake of water including water in food, for the average patient in a day is of the order of 2,000 to 2,500 ml., a rough estimate of the deficit can be approximated.

Clinical symptoms of dehydration are dry tongue, dry mucous membranes, and loss of skin turgor in severe cases, softness of the eye balls, restlessness, and hypotension are also found. The urine is usually scanty and of high specific gravity The hemoglobin and hema

Table 2. Daily Baseline Requirements

	NORMAL ADULT	DEBILITATED PATIENT	ELDERLY OR OBESE
Water	35 mL/kg. Average 2,000 mL/day	30 mL/kg. Average 1,500 mL/day	25 mL/kg. (1,500)
Na Cl	76 mEq/day maximum	less to 0	less to 0
K	40 mEq	Usually > 40 mEq	40 mEq
Carbohydrate	100 gm. minimum	At least 150 gm. in divided doses	100 gm. minimum
Parenteral vitamins	No demonstrable need except for vitamin C	B and C in therapeutic doses	Usually B and C in modest amounts
Protein (amino acids)	Some nitrogen-sparing action, but probably not needed	Essential	If on prolonged I V therapy

Vitamin K in all patients with liver disease, jaundice, or on oral antibiotics

ments can be met with solutions of 5 or 10 per cent glucose in water and that relatively small amounts of electrolytes are required. A typical baseline order for a 70 kg. adult with 3 degrees of fever would be of 500 mL of 5 per cent glucose in 0.9 per cent sodium chloride, and 2,500 mL of 5 per cent glucose in water containing a total of 60 mEq of potassium chloride *The potassium chloride solution should never exceed 40 mEq per liter in concentration.* The volume of replacement fluid prescribed should be given in divided doses, half in the morning and half in the evening.

2. Dynamic Loss. The surgical patient has two major routes for the abnormal loss of water and electrolytes *the gastrointestinal* tract and wounds, particularly those that are exposed to the external environment. External abnormal losses should be replaced as nearly as possible volume for volume. The electrolyte content of these fluids varies with the type and site of their loss. Table 3 gives the average values.

Considering gastrointestinal tract losses, it may be noticed (Table 3) that with the exception of bile and pancreatic juice, gastrointestinal tract fluids are *hypotonic* to the plasma with respect to sodium and chloride ion concentration and therefore require somewhat *less than isotonic electrolyte replacement. Most* gastric juice is acid and contains chloride in excess of sodium The excess of chloride loss is high in the patient with gastric or duodenal ulcer and low in the debilitated and elderly patient with achlorhydria. In most patients when chloride is lost by vomitus or gastric suction with gastric juice sodium is excreted in the urine in the form of sodium bicarbonate, and the ultimate loss to the body is approximately equal in the two ions. For this reason, *sodium chloride is the replacement fluid of choice* for gastric juice loss.

Small intestinal fluid contains practically equal amounts of sodium and chloride ions although the amount of total base (sodium and potassium) lost increases progressively down the gastrointestinal tract. Because of the slightly increased base loss when compared with chloride, small bowel replacement when the volumes are large (1 000 ml. or more a day) requires the addition of small amounts of either sodium bicarbonate or sodium lactate to the replacement regime as shown in Table 3 Bile is in effect an ultrafiltrate of plasma containing no protein but sodium, potassium, and chloride in approximately the same concentrations as found in plasma. Pancreatic juice is exceptionally alkaline with a large content of sodium bicarbonate, and the loss of large volumes can cause a rapid and excessive loss of base and the occurrence of a metabolic acidosis. Losses from wounds are considered essentially the same as the loss of a plasma solution with electrolytes the same as in the plasma and the protein content only slightly less

Table 3 Replacement of External Losses

	Approximate Values mEq. per Liter Loss		
	Na	K	Cl
1 Vomitus or Gastric Suction (acid)	60	20	100
2 Small Bowel Content (faintly alkaline)	100	10-30	96
3 Bile (quite alkaline)	140	5-10	100
4 Pancreatic Juice (very alkaline)	140	10	70
5 Diarrhea (above 500 ml.)	120-140	30	90
6 Wound Packing and Serous Drainage	140	10	100

(1) Replace gastric suction with ⅓ volume 0.9% NaCl and ⅔ as 5% glucose with 20 mEq KCl per liter

(2) Replace small bowel and diarrheal losses with 70% volume 0.9% NaCl (with glucose), 20% volume glucose in water and 10% volume with either M/6 sodium lactate or M/6 $NaHCO_3$. Potassium losses tend to increase and chloride to decrease, the lower the point of change in small bowel. K loss must be replaced.

(3) Replace bile loss as if it were a protein-free plasma filtrate. ⅔ volume as 0.9% NaCl (with glucose), ⅓ volume of M/6 $NaHCO_3$ or lactate (oral replacement for chronic fistulae 6 gm. enteric coated NaCl, 4 gm. $NaHCO_3$ per liter loss)

(4) Replace pancreatic juice with ½ volume 0.9% NaCl (with glucose) and ½ volume M/6 sodium lactate or $NaHCO_3$.

(5) Same as 2.

(6) Wound drainages are usually of the same electrolyte content as plasma, with variable amounts of protein up to 50 gm. per liter

When volumes of drainage are large (> 1500 ml.), it is wise to determine the exact electrolyte content. The above values are averages, but considerable variability exists from patient to patient.

Internal fluid shifts are somewhat more difficult to assess but are not difficult to visualize when one considers the extensive edema of the burn, or the large volumes of fluid which can and do accumulate within the small bowel in adynamic ileus or intestinal obstruction. These volumes of fluid and their electrolytes *are effectively lost to the extracellular fluid during the period of their entrapment in a localized area.* Their losses must be replaced at least in part in order to maintain the extracellular fluid and the circulating blood volume. They differ from outright external losses only in that when the causative conditions are corrected, the fluid and electrolytes return to the general extracellular fluid volume. When this happens the patient receives in effect an auto-infusion which may seriously overload the extracellular fluid space *unless parenteral therapy is markedly curtailed.* Figure 1 illustrates this concept, which has been named the "third space" of injury and shows its formation, the effect of treatment and its resolution (8).

Major alterations in water and electrolyte balance result in two types of disability: *(a)* changes in the volume of extracellular fluid space, cell water or circulating volume and *(b)* changes in the relative electrolyte concentrations. Both phenomena usually exist together although this is not necessarily the case. The surgeon should familiarize himself with the effect of relative changes of ion concentrations in the plasma and with the meanings of the terms *metabolic acidosis, metabolic alkalosis, respiratory acidosis,* and *respiratory alkalosis.* He should be familiar with the reasons why the CO_2 combining power of the plasma is *not* necessarily an indication of alkalosis when it is elevated or of acidosis when it is depressed. The CO_2 of the plasma is elevated

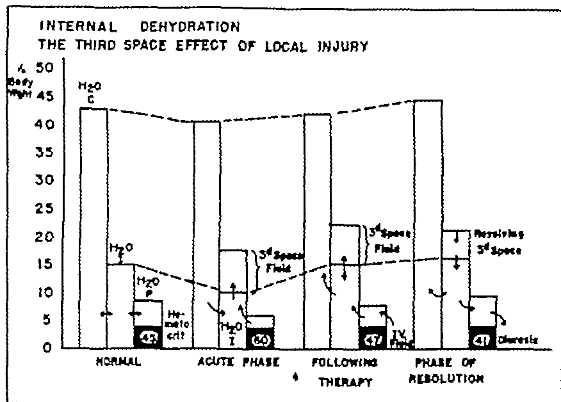


Fig. 1 Illustrating the effects of internal dehydration by injury or ileus with the creation of a third fluid space of unavailable fluid which dehydrates plasma and cells and diminishes available interstitial fluid. Replacement therapy restores normal volumes, and subsequent resolution of third space may overexpand available extracellular fluid. H_2O C is cell water H_2O I is interstitial fluid, and H O P is plasma water

both in metabolic alkalosis and in respiratory acidosis and is depressed in metabolic acidosis and respiratory alkalosis. Table 4 summarizes the major plasma changes found in these four states and indicates briefly the major causes of each (9).

3 **Deficits or Excesses.** As noted in the discussion of preoperative preparation, dehydration, loss of circulatory blood volume, and losses of electrolytes can occur in the postoperative period if adequate attention is not paid to the replacement of baseline and of dynamic losses A rule of thumb to remember is this *If deficits occur quickly they may be replaced quickly and if slow to occur they must be replaced slowly*

Excesses of water and extracellular fluid may exist in patients with chronic cardiac failure in patients in the nephrotic stage of nephritis, and in patients with malnutrition and hypoproteinemia. Ascites and pleural effusions are special types of the same sort of problem. In general, baseline water should be reduced and sodium and chloride eliminated in the parenteral replacement therapy of these patients. Large volumes of dynamic loss must, however be replaced with appropriate electrolytes included.

Another special set of circumstances exists in the patient with acute renal failure from trauma, incompatible blood hypotension, or renal poison. Baseline water is restricted to insensible loss (800 to 1 000 ml per day) Ten per cent glucose is administered to reduce nitrogen breakdown, and small amounts of sodium bicarbonate are given to keep the CO of the plasma at about 15 mEq Articles on this subject should be consulted relative to the management of these cases (10 11) *Certain iatrogenic problems* should be mentioned. Water intoxication, characterized by weakness, delirium, hypotension, and sometimes convulsions can be produced by injudicious administration of large volumes of glucose in water to patients who need electrolyte replacement. All serum electrolyte values are low in these cases. Small amounts (200 to 300 ml.) of 5 per cent sodium chloride solution should be

Table 4 Acidosis and Alkalosis

	Na	K	CO	Cl	CAUSES
1 Metabolic Acidosis pH ↓					
A. Renal	±↓	↑	↓	±↑	Acute or chronic renal failure BUN ↑
B Metabolic	±	↑	↓	↓	Diabetes hypoxia, adrenal insufficiency
C. Hyperchloremia	±↓	±↑	↓	↑	NH Cl, Diamox, renal insufficiency fistulas and diarrhea.
2. Metabolic Alkalosis pH ↑					
A. Alkali administration	↑	↓	↑	±↓	NaHCO excess.
B 1 Cl loss	±	↓	↑	↓	Vomiting, gastric suction.
C Potassium deficiency*	±	↓	↑	↓	Prolonged alkalosis, surgical stress no K intake
D Mixed K and Cl loss	±	↓	↑↑	↓	Usual pattern of g.i. loss without K replacement.
3 Respiratory Acidosis					
A. Acute pH ↓	±	↑	±↑	±	Narcotics, anesthesia, atelectasis, obstruction.
B Compensated pH ±	±	±	↑	↓	Asthma, emphysema, bronchiectasis.
4 Respiratory Alkalosis					
A. Early pH ↑	±↓	↓	↓	↑	Hyperventilation due to fever CNS lesions, NH toxicity salicylates, respirators.
B Compensated pH ±	↓	↓	↓↓	↑	
C Late pH↓ (Marked dehydration)	↓	↓	↓↓	±↓	

Urine is alkaline
Urine is acid.

used discriminately to treat these cases.

Failure to administer potassium to patients with large losses will result in potassium deficiency characterized by weakness, irritability ileus, electrocardiographic changes a plasma alkalosis and an acid urine (8, 12)

Clysis of glucose in water will produce an active temporary drop in circulating blood volume and sometimes a shocklike state Thus is an iatrogenic "third space" (13)

The requirements for fluid and electrolytes for a surgical patient equal baseline *plus abnormal losses, and either plus an allocation for deficits or minus a deduction for excesses.* For example

1 Male patient, 70 kg., with pyloric obstruction due to duodenal ulcer Gastric aspirations, 2,000 ml urine volume 1 100 ml. infusion the previous day 3 800 ml.

Think.		
Baseline	2,000 ml.	1,500 ml 5% glucose in H O 500 ml. 5% glucose 0.9% NaCl 40 mEq KCl
Dynamic loss	2,000 ml.	1,500 ml. 0.9% NaCl 500 ml. 5% glucose in H O 40 mEq KCl
Deficit or excess	none	4,000 ml.

Order A M.—1,000 ml 5% glucose 0 9 % NaCl + 20 mEq KCl
1,000 ml 5% glucose in H O + 20 mEq KCl
P M —exactly the same as A M

2. Female patient, 60 kg., with ileus of small bowel, long tube in jejunum. Drainage previous 24 hours, 1 800 ml total infusion, 2,500 ml. Urine output, 400 ml specific gravity 1.026 Patient is moderately dehydrated since previous day CO_2 18 mEq Cl 100 mEq BUN 24 Na 136 K 5.3 hematocrit 52.

Think. Baseline
Dynamic loss
Deficit of extracellular fluid
Some acidosis probably largely metabolic, dehydration basis, with some renal embarrassment
Potassium elevated slightly probably due to dehydration

Prescribe Baseline — 2,000 ml.
Dynamic loss — 1,800 ml.
To rehydrate (estimate) — 1,500 ml.
5,300 ml.

For baseline — 1,500 ml. glucose in H_2O
500 ml. glucose 0.9% NaCl

For tube drainage — 1,000 ml. glucose saline
500 ml. M/6 sodium lactate
300 ml. glucose in H_2O

For rehydration — 1,000 ml. glucose saline
500 ml. M/6 sodium lactate
5,300 ml.

Order A.M.— 500 ml. M/6 sodium lactate
1,500 ml. 5% glucose 0.9% NaCl
1,000 ml. 5% glucose in H_2O
Check tube drainage for 8 hour volume check urine volume

P.M.— 1,000 ml. 5% glucose saline
500 ml. M/6 sodium lactate
800 ml. 5% glucose in H_2O
Order hematocrit and chemistries for A.M.

Think. She ought to be fairly well hydrated tomorrow and probably her potassium will fall, as she has large losses. I will order some potassium chloride tomorrow morning if her urine volume is up and I will check the report of the potassium serum level. When the ileus begins to resolve, some "third space" fluid will be absorbed. Accordingly I will watch for this and reduce the volume of intravenous fluids as indicated.

OTHER ASPECTS OF POSTOPERATIVE CARE

1 Sedation. Children and elderly patients tolerate narcotics poorly Narcotics tend to depress respiration in all patients and to produce respiratory acidosis. Use them sparingly *Restlessness* in the postoperative patient is more likely to be due to *hypoxia* than to pain. Check! Remember that opiates depress G I tract function.

2. Antibiotics. Overuse of antibiotics results in resistance and may mask serious wound or intraperitoneal problems. The patient who has a clean wound with solid closure of viscus, good hemostasis, and no dead space dead tissue, or retroperitoneal dissection does not need antibiotics In the treatment of postoperative atelectasis, antibiotics are a poor substitute for coughing and intratracheal suction Blind, routine ordering of antibiotics is bad treatment. Think before you prescribe

3. Wounds. A surgical wound does not become infected unless bacteria are brought to it. Your wound dressing technics should be just as careful as your operating room technics. Use asepsis and avoid antisepsis.

4. Oral Intake Patients with surgery of the extremities, including the head and neck, can usually tolerate fluids within 24 hours after operation and should have an adequate intake within 48 hours

Abdominal surgery and retroperitoneal sur

gery *always* result in some degree of ileus. Also many thoracic procedures do but to a lesser degree. Do not rush oral intake wait until peristalsis returns and *persists* for at least 12 hours. Then start slowly Do not give a patient who is on gastric siphonage suction anything by mouth, because you only increase the loss of electrolytes from the stomach. If the security of the anastomosis is questionable a delay in starting oral intake for an extra day or two longer is believed advisable Also remember that there is no perfect substitute for oral intake either in nutrition or in water and electrolyte balance Use nature s method as soon as it is safe to do so

5. Remember that the normal response to surgery includes the following:

- *a.* Antidiuresis for 12 to 24 hours
- *b* Fever of modest degree
- *c.* Leukocytosis
- *d.* Renal retention of Na+ and Cl−
- *e.* Increased nitrogen and potassium loss
- *f* Some "third space" effect, from a little to a lot depending on wound size and how traumatic the surgery
- *g.* A fall in serum sodium to levels of 135 mEq per liter or even 132 is *normal* following major operations and should not be treated per se

6. Laboratory Tests. If a laboratory test does not fit the clinical picture repeat the test. Don t treat numbers. Treat the patient!

Most patients will recover from surgery if they are not abused It is only for the very sick patients that time and more time is required.

Avoid routine orders in fluid replacement therapy Individualize each sick patient and treat that particular patient s problems You can t substitute brine for brains!

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ANESTHESIA

GEORGE A KEATING

THE ACTIVITIES of an anesthesiologist can be divided into four phases. *First* is the preoperative visit to and evaluation of the patient. *Second* is the selection of the anesthetic agents and technic, with due regard to the safety of the patient, the nature of the surgical procedure, the abilities of the anesthesiologist, and the preferences of the patient and the surgeon. *Third* is the actual administration of the anesthetic and the management of the patient's condition during surgery. *Fourth* is the postoperative care and observation of the patient.

In the discussion that follows, the technics recommended in any particular instance do not attempt to set forth all the possible methods of solving an anesthesia problem. They are, however, practical opinions and technics, formulated mainly from close clinical observation of patients in the operating room and in the postoperative period.

THE PREOPERATIVE VISIT

The visit to the patient should be devoted first to obtaining as much information as possible concerning the patient's past history, the present illness, and the physical and laboratory findings. The results of this interview will help the anesthesiologist, working in cooperation with the surgeon, to determine how the patient may best be prepared for anesthesia and the operation. Ideally, this preoperative visit should take place not later than the day before surgery. However, in emergencies, a visit even 10 or 20 minutes before the operation is worthwhile. In addition to the usual medical and surgical history and a complete review of systems, a history of previous anesthesia experiences should be taken to avoid difficulties or a repetition of errors.

This personal contact with the patient is an important part of the preoperative preparation. There is no substitute for the calming effect of an unhurried visit, especially when the calmness is secured without the undesirable side effects accompanying opiates and barbiturates.

During the preoperative visit, the anesthetic technic planned for the operation should be discussed with the patient. A history of idiosyncrasies to drugs or a patient's mental aversion to some particular drug or technic may be elicited. Occasionally a patient has a morbid fear of being put to sleep. More often, he objects to some form of regional anesthesia, usually spinal, either because of hearsay or because of a previous personal experience. Unless there are specific contraindications, it is usually well to respect a patient's expressed desires, both from the standpoint of seeking a successful anesthesia and from the medicolegal aspect. Fairly often a careful but brief explanation of the anesthetic technic and an exposition of its particular value will be sufficient to sway the patient's feelings.

An important, and often little understood, part of this preoperative visit is the ordering of preanesthetic medication. This should not be allowed to become a mere routine but should be adjusted according to the particular requirements of the patient, the anesthesia, and the operation. Preanesthetic medication has four general purposes: (1) psychic sedation, or hypnosis; (2) elevation of the pain threshold; (3) reduction of metabolism; and (4) counteraction of undesirable side reactions from the anesthetic agent.

1. *Psychic depression* tends to place a protective cloak about the patient and spare him the unpleasant experience of anesthesia and surgery. While it may or may not provide actual amnesia, it should confer a state of indifference. A patient in such a state is more amenable to methods of regional anesthesia. Furthermore, the lack of excitement is an aid in the induction of general anesthesia.

2. *Elevation of the pain threshold* is particularly suited to regional anesthesia, because with this technic not all sensation is necessarily abolished. Pain perception may be blocked, but the deeper pathways conducting traction and pressure sensations remain active. These sensations are interpreted by many patients as pain.

3. *Reduction of tissue metabolism* causes a decrease in the amount and concentration of the various agents necessary to attain a satis-

factory plane of anesthesia or analgesia. This is closely allied to psychic depression, but it is concerned more with the patient's safety than with his comfort.

4 *Counteraction of undesirable side reactions* from the anesthetic agent is exemplified by the use of belladonna alkaloids to minimize the respiratory secretions caused by irritating inhalants and to decrease the incidence of laryngospasm, which is frequently associated with the administration of intravenous barbiturates Another example is the effect of barbiturates in protecting against the convulsive effects of local anesthetic agents.

With the four purposes of preanesthetic medication in mind, a careful review of the drugs usually employed can be considered. All drugs have undesirable reactions as well as desirable ones, and they must be chosen as carefully as the anesthetic agent itself

1 *Drugs used for psychic sedation* include the opiates, both natural and synthetic· the barbiturates and their related compounds and the basal narcotic agents such as avertin. Of these, the opiates are the most commonly employed they should be used with discretion, especially in the extremes of age. Caution is mandatory first because of the effect of opiates in depressing respiration, and also because of their less recognizable effects in interfering with circulatory hemostasis. For this second reason opiates are avoided in all patients with any existing circulatory depression This includes the patient who is either in shock or recently recovered from shock unless there is severe pain. Barbiturates in moderate amounts are useful in all age groups except in the occasional patient who experiences excitement rather than sedation. Patients in severe pain may also be excited by use of barbiturates Basal narcotics are rarely used, since less potent and less depressing drugs may be more readily employed. Chlorpromazine and its related compounds have the disadvantage of frequently causing hypotension and a delay in the recovery period following general anesthesia.

2. *Principal drugs used for raising the pain threshold* are the opiates. Most patients about to undergo elective surgery do not have pain. Patients in shock usually do not have painful sensations until they attain a normotensive state The use of opiates will only delay this recovery mechanism Indeed, opiates given by the customary subcutaneous or intramuscular route may not be absorbed until the circulation returns to almost normal levels. It seems more logical to reserve the opiates for intravenous use during regional anesthesia either when the block is incomplete or when the patient misinterprets touch or pressure sensation as pain In general, barbiturates are preferred to opiates for administration prior to anesthesia.

3 *Drugs for decreasing the metabolic rate* include opiates, barbiturates, and a variety of other sedatives. The preceding admonitions should govern their use.

4 *Agents used for counteraction of undesirable side reactions* include belladonna alkaloids and barbiturates. Atropine and scopolamine are prescribed for all patients even when regional anesthesia is employed, in the event that general anesthesia may be required for supplementation. Because of its prolonged action, better drying of secretions, and additional hypnotic effect, scopolamine is preferred for all except the aged and those patients undergoing intrathoracic procedures Atropine is probably more effective in blocking undesirable vagal reflexes, and it will not tend to disorient the aged patient.

The dosage of all these premedication drugs must be adjusted to the age and general physical condition of the patient. Patients less than one year of age generally receive no premedication with the exception of an occasional small dose of atropine (1/400 grain) Older children receive regular medication calculated according to age or preferably according to body weight. Doses of all types of drugs are markedly reduced in the elderly age groups.

Routinely the preanesthetic medication is given either subcutaneously or intramuscularly one hour before the scheduled time of surgery If less time is available the intravenous route should be chosen with the dosage schedule unchanged This routine has been adopted because morphine a commonly used drug, reaches its peak effect approximately 90 minutes after subcutaneous administration, 45 minutes after intramuscular administration, and about 10 minutes after intravenous injection. Most other drugs reach their peak effect more rapidly

After all the available information has been gathered concerning the patient, the premedication prescribed and the confidence of the patient gained, the purpose of the preoperative visit has been achieved.

SELECTION OF ANESTHETIC TECHNIC AND AGENT

The second concern is the selection
proper anesthetic techni

technic may be either regional or general. Regional anesthesia may be spinal, epidural, paravertebral block, regional nerve block, field block, or local infiltration. General anesthesia may be induced by inhalation and intravenous or rectal administration, each route permitting the use of a large number of technics. Various combinations of any of these methods may be used. For regional anesthesia the principal agents which we prefer are tetracaine, lidocaine, dibucaine, and chloroprocaine. Other available agents offer no particular advantages. Inhalation agents used include vinyl and ethyl ether nitrous oxide, ethylene, and cyclopropane The thiobarbiturates are employed intravenously and either these drugs or avertin may be given rectally

In choosing an agent and technic, the safety of the patient is the primary concern. This involves a thorough knowledge of the physical status of the patient, not only medically but also from the standpoint of age, sex, race, and psychic make-up It also demands a complete understanding of the pharmacologic action of the anesthetics to be used, and how these anesthetics may affect the status of the patient as a whole. As an example, a patient with coronary artery disease should not be allowed to have a long, stormy induction with ether even though ether might be considered the best anesthetic to use. Under such circumstances it is better to induce anesthesia with a small amount of a barbiturate administered intravenously and then subsequently maintain the anesthesia with ether A barbiturate is not a good drug for prolonged anesthesia, but it serves an excellent purpose when its use is properly indicated.

As noted earlier the next criterion governing the choice of anesthetic is the type, extent, and duration of the operation. Since this involves lengthy consideration, it will be discussed in detail in a separate section to follow For the moment let us consider how the abilities of the anesthesiologist influence the choice of anesthetic. Most authorities think that the anesthesiologist should use the technic that best suits his abilities, regardless of whether it is the most generally favored method or not.

The anesthesia should be discussed with the patient during the preoperative visit and his fears or prejudices respected as far as possible. Many surgeons have their preferences too Those accustomed to the extreme relaxation afforded by spinal anesthesia may not be satisfied with inhalation anesthesia. Others may not care to operate on a patient who is conscious of all that transpires in the operating room.

The relationship of the anesthesia to the nature of the surgical procedure is best considered by grouping operative procedures according to their general anatomic localities.

OPERATIONS ABOUT THE NECK

These operations must all be considered to be major procedures from the viewpoint of anesthesia, whether the operation is for a sebaceous cyst or for a radical neck dissection. Once anesthesia is induced and the patient is prepared and draped for surgery the anesthesiologist must work in a restricted area. Since there is always the possibility of interference with the airway by the surgical procedure and since there are many untoward reflexes encountered in this region, the use of an endotracheal tube is mandatory when general anesthesia is used. In a few unusually cooperative patients regional block may be employed.

If a patient has signs of respiratory obstruction preoperatively or if there is a deep infection present, the endotracheal tube should be introduced under topical anesthesia while the patient is awake and in command of his own airway If this is not feasible, an airway should be secured by performing a preliminary tracheostomy

Probably the most common operation in the neck region is a thyroidectomy While anesthesia for this procedure can satisfactorily be managed by performing both a superficial and a deep cervical plexus block, only rarely will a patient tolerate this method. The discomfort caused by unavoidable pressure and traction during the operation is not conducive to the patient s peace of mind.

Patients with toxic goiter almost universally require general anesthesia in order to avoid additional psychic stimulation. Premedication dosages in these patients are heavy Frequently a basal anesthesia achieved by the intravenous or rectal route is used. Either light oxygen-ether or nitrous oxide–oxygen–ether is our anesthetic of choice. Ethylene is also an excellent agent. Cyclopropane is avoided in the toxic patient because of its effect on cardiac rhythmicity Intubation may be facilitated by the use of a muscle relaxant. The thiobarbiturates have a cumulative effect and delay the time of reaction. Since these patients often have myocardial damage, careful observation of the cardiovascular status is important.

Fortunately the preoperative preparation of patients with hyperthyroidism including the use of thiouracil and the iodides, has reduced the incidence of thyroid crises during anesthesia almost to the vanishing point. Anesthetic management of the nontoxic thyroid patient is essentially the same except that the cardiovascular status is usually better and basal anesthesia is not frequently employed.

In thyroid patients the airway problem is carried into the postoperative phase. Obstruction may occur as a result of vocal cord paralysis or paresis from edema caused by the endotracheal tube, or by surgical trauma and by tracheal collapse when there has been erosion of the cartilaginous rings by a tumor mass. For these reasons all thyroidectomy patients should have a tracheostomy set at the bedside for at least 24 hours postoperatively and be closely observed during that time for signs of airway obstruction.

Anesthesia for removal of thyroglossal or branchial cysts parathyroid tumors, and hygromas is essentially the same as that required for thyroidectomy or nontoxic goiter. Anesthesia for radical neck dissection follows the same pattern. In this procedure the carotid sinus reflex may be markedly stimulated, with deleterious effects on the circulation. The surgeon may avoid this effect by careful dissection and retraction and by topical application of cocaine (4 per cent) or pontocaine (2 per cent) directly to the region of the carotid bifurcation.

In some procedures the surgeon may prefer to use the electrocautery. Then nonexplosive anesthetic agents must be used. Nitrous oxide combined with minimal amounts of thiobarbiturate administered intravenously or rectally or avertin given rectally is most commonly used.

OPERATIONS ON THE THORACIC WALL

These range from excision of simple cysts to removal of parts of the thoracic wall itself. With simple procedures, local or field block may be ideal. In more extensive operations, paravertebral blocks may be employed. Almost any inhalation or intravenous technic may be used since no relaxation is required. Furthermore the anesthesiologist has access to the patient and can easily maintain a patent airway.

Mastectomy simple or radical, involves only the soft tissues but can rarely be carried out under regional anesthesia because of the large area involved. General anesthesia with any of the inhalation agents is excellent. Because of the extensive tissue dissection required, a fairly large blood loss through constant oozing is common. Careful attention to the airway and to carbon dioxide elimination helps to keep the venous pressure from rising and increasing the blood loss. Often the use of an endotracheal tube to insure a good airway is advisable. Commonly thiobarbiturate and nitrous oxide are used for preliminary excision of a lesion for examination by frozen section. If a radical operation is to follow a volatile or gaseous agent is substituted.

INTRATHORACIC OPERATIONS

These involve surgery of the pleura, lungs, trachea, bronchi, mediastinum, and diaphragm. In general, the management of these procedures requires the highest degree of skill on the part of the anesthesiologist. Surgery of the thorax and its contained viscera has been until recently a last frontier.

Operations on the pleura may include the simpler procedures of removing collections of purulent material, blood, or fluid from the pleural space. These are performed under local or regional anesthesia. The operation may involve very extensive resections of tumors, necessitating the removal of a part of the thoracic wall or the decortication of fibrous tissue either of which requires careful endotracheal technics. Cutaneous tracheobronchial fistulas often present a special problem which can best be solved by employing endobronchial intubation. This is most easily accomplished with the Carlens double lumen tube.

Pneumonectomy may be partial or complete. Complete pneumonectomy is technically simpler. It requires the use of an endotracheal tube for anesthesia. Any of the inhalation agents may be used to attain the light plane of surgical anesthesia required. Because these patients commonly suffer from chronic pulmonary insufficiency assisted or controlled respiration is necessary to maintain an adequate exchange. Controlled respirations are most easily attained by using cyclopropane or by supplementary muscle relaxants. This technic gives a quiet operative field for the surgeon and is almost a necessity in some of the more delicate surgical procedures. The lung to be removed often contains large amounts of secretions, and the usual positioning of the patient places this side upward. Accordingly frequent and vigorous tracheobronchial toilet is neces-

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Probably the most common operation in the neck region is a thyroidectomy While anesthesia for this procedure can satisfactorily be managed by performing both a superficial and a deep cervical plexus block, only rarely will a patient tolerate this method. The discomfort caused by unavoidable pressure and traction during the operation is not conducive to the patient's peace of mind.

Patients with toxic goiter almost universally require general anesthesia in order to avoid additional psychic stimulation. Premedication dosages in these patients are heavy Frequently a basal anesthesia achieved by the intravenous or rectal route is used. Either light oxygen-ether or nitrous oxide–oxygen–ether is our anesthetic of choice. Ethylene is also an excellent agent. Cyclopropane is avoided in the toxic patient because of its effect on cardiac rhythmicity Intubation may be facilitated by the use of a muscle relaxant. The thiobarbiturates have a cumulative effect and delay the time of reaction Since these patients often have myocardial damage careful observation of the cardiovascular status is important.

Fortunately the preoperative preparation of patients with hyperthyroidism including the use of thiouracil and the iodides, has reduced the incidence of thyroid crises during anesthesia almost to the vanishing point. Anesthetic management of the nontoxic thyroid patient is essentially the same except that the cardiovascular status is usually better and basal anesthesia is not frequently employed.

In thyroid patients the airway problem is carried into the postoperative phase. Obstruction may occur as a result of vocal cord paralysis or paresis from edema caused by the endotracheal tube, or by surgical trauma and by tracheal collapse when there has been erosion of the cartilaginous rings by a tumor mass. For these reasons all thyroidectomy patients should have a tracheostomy set at the bedside for at least 24 hours postoperatively and be closely observed during that time for signs of airway obstruction.

Anesthesia for removal of thyroglossal or branchial cysts, parathyroid tumors, and hygromas is essentially the same as that required for thyroidectomy or nontoxic goiter Anesthesia for radical neck dissection follows the same pattern In this procedure the carotid sinus reflex may be markedly stimulated, with deleterious effects on the circulation The surgeon may avoid this effect by careful dissection and retraction and by topical application of cocaine (4 per cent) or pontocaine (2 per cent) directly to the region of the carotid bifurcation.

In some procedures the surgeon may prefer to use the electrocautery Then nonexplosive anesthetic agents must be used. Nitrous oxide combined with minimal amounts of thiobarbiturate administered intravenously or rectally or avertin given rectally is most commonly used.

OPERATIONS ON THE THORACIC WALL

These range from excision of simple cysts to removal of parts of the thoracic wall itself With simple procedures, local or field block may be ideal. In more extensive operations, paravertebral blocks may be employed. Almost any inhalation or intravenous technic may be used since no relaxation is required. Furthermore, the anesthesiologist has access to the patient and can easily maintain a patent airway

Mastectomy simple or radical, involves only the soft tissues but can rarely be carried out under regional anesthesia because of the large area involved. General anesthesia with any of the inhalation agents is excellent Because of the extensive tissue dissection required, a fairly large blood loss through constant oozing is common. Careful attention to the airway and to carbon dioxide elimination helps to keep the venous pressure from rising and increasing the blood loss. Often the use of an endotracheal tube to insure a good airway is advisable Commonly thiobarbiturate and nitrous oxide are used for preliminary excision of a lesion for examination by frozen section. If a radical operation is to follow a volatile or gaseous agent is substituted.

INTRATHORACIC OPERATIONS

These involve surgery of the pleura, lungs, trachea, bronchi, mediastinum, and diaphragm In general, the management of these procedures requires the highest degree of skill on the part of the anesthesiologist. Surgery of the thorax and its contained viscera has been until recently a last frontier

Operations on the pleura may include the simpler procedures of removing collections of purulent material, blood, or fluid from the pleural space. These are performed under local or regional anesthesia. The operation may involve very extensive resections of tumors, necessitating the removal of a part of the thoracic wall or the decortication of fibrous tissue, either of which requires careful endotracheal technics Cutaneous tracheobronchial fistulas often present a special problem which can best be solved by employing endobronchial intubation. This is most easily accomplished with the Carlens double lumen tube

Pneumonectomy may be partial or complete. Complete pneumonectomy is technically simpler It requires the use of an endotracheal tube for anesthesia. Any of the inhalation agents may be used to attain the light plane of surgical anesthesia required. Because these patients commonly suffer from chronic pulmonary insufficiency assisted or controlled respiration is necessary to maintain an adequate exchange. Controlled respirations are most easily attained by using cyclopropane, or by supplementary muscle relaxants. This technic gives a quiet operative field for the surgeon and is almost a necessity in some of the more delicate surgical procedures. The lung to be removed often contains large amounts of secretions, and the usual positioning of the patient places this side upward. Accordingly frequent and vigorous tracheobronchial toilet is neces-

technic may be either regional or general. Regional anesthesia may be spinal, epidural, paravertebral block, regional nerve block, field block, or local infiltration. General anesthesia may be induced by inhalation and intravenous or rectal administration, each route permitting the use of a large number of technics. Various combinations of any of these methods may be used. For regional anesthesia the principal agents which we prefer are tetracaine, lidocaine, dibucaine and chloroprocaine. Other available agents offer no particular advantages. Inhalation agents used include vinyl and ethyl ether nitrous oxide, ethylene, and cyclopropane The thiobarbiturates are employed intravenously and either these drugs or avertin may be given rectally

In choosing an agent and technic, the safety of the patient is the primary concern. This involves a thorough knowledge of the physical status of the patient, not only medically but also from the standpoint of age, sex, race, and psychic make up It also demands a complete understanding of the pharmacologic action of the anesthetics to be used, and how these anesthetics may affect the status of the patient as a whole. As an example, a patient with coronary artery disease should not be allowed to have a long, stormy induction with ether even though ether might be considered the best anesthetic to use Under such circumstances it is better to induce anesthesia with a small amount of a barbiturate administered intravenously and then subsequently maintain the anesthesia with ether A barbiturate is not a good drug for prolonged anesthesia, but it serves an excellent purpose when its use is properly indicated.

As noted earlier the next criterion governing the choice of anesthetic is the type, extent, and duration of the operation. Since this involves lengthy consideration, it will be discussed in detail in a separate section to follow For the moment let us consider how the abilities of the anesthesiologist influence the choice of anesthetic. Most authorities think that the anesthesiologist should use the technic that best suits his abilities, regardless of whether it is the most generally favored method or not.

The anesthesia should be discussed with the patient during the preoperative visit and his fears or prejudices respected as far as possible. Many surgeons have their preferences, too. Those accustomed to the extreme relaxation afforded by spinal anesthesia may not be satisfied with inhalation anesthesia. Others may not care to operate on a patient who is conscious of all that transpires in the operating room.

The relationship of the anesthesia to the nature of the surgical procedure is best considered by grouping operative procedures according to their general anatomic localities.

OPERATIONS ABOUT THE NECK

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sary in order to keep the normally functioning lower lung free and clear

In lobectomy or in segmental lobectomy the problems are more complex because the surgery is more prolonged. In order to maintain assisted or controlled respirations, manual or mechanical inflation may be used. Each method has advantages and adherents. It is easier to interpret the patient's reactions with the manual method, but maintaining uniform and vigorous respirations for several hours without tiring is most difficult. The actual value of maintaining satisfactory respiratory exchange and aiding the circulation in the negative phase attributed to some mechanical respirators is open to question, but they are not believed harmful.

In our clinic the anesthesia of choice in most intrathoracic procedures involves a semiclosed system using nitrous oxide-oxygen-ether at a total flow rate of 3 to 6 liters per minute and with respirations either assisted or controlled. This is considered the best safeguard against carbon dioxide retention. Minute-to-minute control of the depth of anesthesia can be attained with the occasional supplementary use of cyclopropane. Except occasionally for induction, thiobarbiturate is not used because of its cumulative effect.

Other intrathoracic procedures involving the esophagus and mediastinal structures, or thoracic sympathectomy are managed in the same manner as lung operations. A complicating factor may be the production of a bilateral pneumothorax. However this requires mainly a slightly more vigorous effort at artificial support of the respiratory exchange.

Other intrathoracic operations becoming more common involve the aorta and great vessels and the heart itself. As a general rule, the anesthetic technics involve the same precautions and use the same agents as for all intrathoracic procedures. The plane of anesthesia is kept as light as possible while still allowing the patient to tolerate the endotracheal tube.

The pericardium is not very often the site of a surgical procedure. The most common operation is that for constrictive pericarditis. The most troublesome complication is an irritable myocardium. Otherwise, the same precautions relating to intrathoracic surgery in general are observed.

Because of the improvements in surgical technics, in anesthesiology in diagnostic methods and in the proper selection of patients, the correction of the various types of congenital anomalies of the heart is possible. One of the simpler procedures is closure of the patent ductus arteriosus. In general, the operation is done on children in whom the myocardium is in good condition. Except for a rise in diastolic pressure when the patent ductus is occluded, there are no special hazards to be expected. It is well for the surgeon to occlude this vessel temporarily while the anesthetist watches for changes in the circulatory dynamics before a permanent ligature is applied. Otherwise, the anesthetic management follows the course of any open thoracic procedure. The volume of blood replacement should equal the quantity that is lost. In these patients cyanosis is absent except in those who are either in congestive heart failure (cyanosis tardive) or in whom there is a reversal of flow with a right to-left shunting of blood. Cyanosis due to reversal of flow is at present considered a contraindication to operation.

In operations to correct the tetralogy of Fallot, it must be remembered that these patients are cyanotic and have an increase both in the blood volume and in the hematocrit readings. Hence the volume of blood replacement should always be well below that which is lost. It is important in these and in other cyanotic cardiac patients to avoid an increase in the oxygen needs of the tissues by not allowing the patient's body temperature to rise. Such heat retention is common with closed "to-and fro" anesthesia systems and, to a lesser degree with closed-circle absorption systems. In such procedures it is well to employ a nonrebreathing or semiclosed absorption system for most of the time and to use the closed system only while it is necessary to maintain inflation of a collapsed lung.

When closely monitored, the body temperature of young patients under semiclosed anesthesia and in a cool operating room will usually fall three to four degrees below normal. Since this fall in body temperature reduces the oxygen demand of the tissues, it is a desirable state. Such a drop in temperature may be artificially obtained by the appropriate use of ice bags or a cooling blanket or mattress.

One of the most frequent operations performed on the heart valves is mitral valvotomy or commissurotomy. The cardiovascular status of these patients varies from reasonably good to poor. Auricular fibrillation, varying degrees of cardiac failure, and even unsuspected rheumatic activity may be present. The state of the myocardium depends on the severity and the

duration of the lesion and also on the number and severity of the attacks of rheumatic fever In patients with mitral stenosis, there is congestion of the pulmonary circulation, and since this blood is suddenly released into the systemic circulation after commissurotomy the volume of the blood replacement should be less than the volume of the blood loss.

These procedures like all cardiac procedures, are monitored on the cardioscope Increase in the number of ventricular complexes or other changes in rhythm or conduction are indications to interrupt the operation either temporarily or permanently and to increase pulmonary ventilation. The amount of anesthetic agent required by these patients is remarkably little. It is our practice to induce anesthesia with a small amount (150 to 200 mg.) of thiobarbiturate and to maintain it with nitrous oxide–oxygen–ether using a semiclosed system. A very light plane of anesthesia is maintained, although not quite as light as that of so-called ether analgesia. Premedication is also very light. To prevent tachycardia, belladonna drugs are usually not used in patients who have a normal sinus rhythm. Opiates when prescribed are given in small doses. Frequently the use of intramuscular pentobarbital is preferred.

Aortic and pulmonic valvotomy may be accomplished by a blind technic, either inferiorly through the ventricular wall or superiorly through an artificially attached appendix made either of pericardium or of a combined cotton cloth and plastic material. Neither of these approaches involves any greater problem of anesthesia than any other cardiac procedure, except that patients with aortic lesions are more prone to disturbances in cardiac rhythm and have more changes in circulatory dynamics during and after the operation There is a growing tendency to attempt the repair of these lesions as well as the repair of cardiac septal defects under direct vision. This necessitates either the temporary but complete interruption of the entire circulation in conjunction with hypothermia, or the use of the pump oxygenator to bypass the cardiopulmonary circulation.

Hypothermia has been used with some success. This allows complete occlusion of the circulation for short intervals of time and provides the advantage of operating on a relatively empty though beating, heart. Total occlusion in our experience has not exceeded four and one-half minutes and in the surviving patients no untoward effects have been observed.

The chief danger in hypothermia is the occurrence of ventricular fibrillation, a condition which is extremely difficult to correct in the cool heart. During cooling, close observation of the cardiac rhythm by electrocardiographic monitoring is essential Any changes in rhythmicity at any point in the cooling are an indication for rewarming the patient and abandoning this technic.

Children and patients of small stature are more readily cooled, and their temperatures tend to drift to lower levels, almost uncontrollably at times. We have assumed a level of 85 to 86 F to be a reasonably safe compromise between ventricular fibrillation at lower temperatures and cerebral damage during the period of circulatory occlusion at higher temperatures. The basic anesthetic agent is ether–oxygen, and induction is obtained with small amounts of either thiobarbiturate or cyclopropane. Controlled respirations are vigorously maintained throughout, using a semiclosed system. Every effort is made to avoid carbon dioxide retention The anesthetic agent is given, in reduced amounts, even during the period of the lowest temperature During circulatory occlusion, troublesome excursions of the diaphragm may be experienced even though respirations were previously under complete control. Effective control may be obtained by administering *d* tubocurarine about 10 minutes before occlusion.

Rewarming is started at the time of occlusion, but there is a lag of about 45 minutes before any temperature rise is detectable by observations of the rectal temperature. The rewarming blanket is never raised above a temperature of 120 F in order to avoid burning the patient.

ABDOMINAL SURGERY

Like other types, abdominal surgery may be performed for conditions of either an acute or chronic nature This strongly influences our choice of anesthesia. Anesthesia for upper abdominal surgery is more trying because of the difficulty in securing adequate muscle relaxation and because of the reflex effects of surgical manipulation on circulation and respiration.

Operations upon the biliary tract are the most common procedures in the upper portion of the abdomen Because of the marked relaxation obtained and the lack of toxic ef

fects on the liver which may frequently be diseased, spinal anesthesia is preferred. It has three disadvantages, however (1) hypotension may develop as a result of the sympathetic blockade, which produces analgesia to a level of the sixth thoracic dermatome or higher (2) respiratory depression may occur because of intercostal paralysis (3) the patient may complain of discomfort during traction on the abdominal viscera. These disadvantages are out weighed by the optimum operating conditions and by the usual lack of sequelae to the spinal anesthesia itself Not only is there extreme muscle relaxation, but the intestines con stricted as a result of the spinal block, are easily retracted This is believed to result in less trauma to the intestines and to lessen the incidence of postoperative ileus and vomiting.

The hypotension, if it occurs, can be cor rected by the use of vasopressors, usually methoxamine or phenylephrine, administered intravenously either intermittently or in a con tinuous drip Respiratory depression is con trolled by manual compression of the re breathing bag filled with oxygen. Discomfort from manipulation of the intraabdominal viscera is of short duration and may be con trolled by nitrous oxide inhalation, demerol administered intravenously or a combination of both. This combination of therapy can bring about the unwise use of a multiplicity of drugs, but this is the exception rather than the general practice. Often spinal anesthesia plus normal premedication is entirely adequate. Sometimes, in apprehensive patients, small amounts of one of the barbiturates given intravenously are used to allay fear and anxiety

Arteriosclerotic heart disease, with or without hypertension, is considered a contraindication to spinal anesthesia. Instead, oxygen–ether or nitrous oxide–oxygen–ether is employed.

Spinal anesthesia is also used in most of the operations on the stomach, including subtotal gastrectomy gastroenterostomy and partial *resection of the vagus nerves. The same varia* tions of technics are employed as previously indicated to obtain the best type of anesthesia.

In gastric surgery for uncontrollable hemor rhage, the problem of hypovolemia is an im portant one. Under such circumstances cyclopropane anesthesia is preferred because of its tendency to interfere less with the circulatory homeostatic mechanisms than any other agent. Hypotension as a result of spinal anesthesia in a patient with a markedly reduced blood volume is a complication very difficult to control It is because of this difficulty that spinal anesthesia is not used in cases of traumatic rupture of the spleen and hemoperitoneum. Cyclopropane is the first choice, light ether or nitrous oxide–ether the second. With either of these agents, muscle relaxants may also be employed as indicated.

In surgery of the spleen for hypersplenism and other forms of blood dyscrasia, spinal an esthesia is preferred. Theoretically ether causes the normal spleen to contract, cyclopropane has no effect, and spinal anesthesia will cause dilatation However it is extremely doubtful that the pathologic spleen has the ability to contract or dilate according to the particular type of anesthesia that is administered.

Intestinal obstruction, if not severe, is managed best by spinal anesthesia. In any of these cases, spontaneous rupture of the bowel as a result of spinal anesthesia is a rarity In cases of advanced intestinal obstruction with the pa tient acutely ill, dehydrated and in acid base imbalance, and possibly in shock, spinal anesthesia is contraindicated. Despite the presence of a Levin tube in the stomach, there is a possibility that after the administration of a spinal anesthetic the patient may regurgitate and aspirate sufficient of the gastric contents to cause an immediate asphyxiation. Accordingly the safest technic is to insert a cuffed endotracheal tube under topical anesthesia while the patient is conscious. Then the cuff is inflated to seal off the trachea and, using either cyclopropane or nitrous oxide–ether sequence, general anesthe sia is induced.

Elective surgery of all types on the gastroin testinal tract is best accomplished with spinal anesthesia because of its excellent relaxation, constriction of the intestinal tract, minimal ef fect upon the acid base and electrolyte bal ance, and less postoperative distention.

Spinal anesthesia should be given with cau tion to the patient with generalized peritonitis. The infection may well cause fixation of the abdominal wall muscles and the diaphragm. If the spinal anesthesia causes intercostal paraly sis of any degree, respiratory exchange may be severely embarrassed.

Anesthesia for pelvic surgery is technically much simpler than that for other types of intraabdominal surgery Gynecologic procedures are performed under spinal anesthesia with ease, and the problems of hypotension,

respiratory insufficiency and traction pain are minimal.

Prolonged spinal anesthesia may be obtained either by the addition of epinephrine in the amounts of 0 6 or 0 7 mg. to a single dose of the spinal anesthetic or by using the catheter spinal technic. The latter has become quite uncommon except in the replacement of the abdominal aorta by grafting after the excision of an aneurysm and in other time-consuming intraabdominal operations.

Intraabdominal surgery in children is performed under inhalation anesthesia—not because the value of spinal anesthesia is questioned, but because children in general seem to be temperamentally unsuited to any type of regional anesthesia. In the child, strange sights and sounds and the loss of sensation and motor power in a part of the body generally tend to cause a state of panic.

Herniorrhaphy of the abdominal wall is a very common surgical procedure which is performed most often in the younger more vigorous age group Chronic cough is frequently a contributing factor in the production of any hernia, congenital or acquired. Therefore, the anesthetic used should be designed to avoid irritation of the respiratory tract as much as possible.

Theoretically local anesthesia would be ideal for inguinal hernia. However local anesthesia for hernia repair requires considerable skill in its application and much gentleness in handling tissues to obtain the best results. In addition, the anatomy of the region is often distorted by the volume of anesthetic solution that is required. Last but not least, local anesthesia for hernia requires considerable fortitude on the part of the patient. Almost all hernia repairs in our clinic are completed under spinal anesthesia which may be complemented by intravenous barbiturate.

In emergency operations for strangulated or incarcerated hernias, spinal is again the anesthesia of choice. When a prolonged operation is anticipated, continuous spinal anesthesia is an excellent choice.

EXTRAPERITONEAL OPERATIONS

These involve many of the same problems as intraabdominal surgery Operations on the kidney and ureter require maximum relaxation, which is satisfactorily obtained with spinal anesthesia, unless a rib resection is required. If this should prove necessary the use of endotracheal anesthesia is mandatory

The removal of either the normal adrenal glands in the treatment of certain forms of osseous metastases or the removal of a pheochromocytoma involves several complicating factors. *First* the pleura may be torn in the manipulation *Second*, there may be a period of a paroxysmal hypertension while the gland or tumor is being handled. *Third*, the blood pressure may descend to shock levels after the tumor or gland is removed. The first of these complicating factors is solved by the use of an endotracheal tube The second is treated by adrenolytic or ganglionoplegic drugs. The third is corrected by the use of vasopressor drugs, notably phenylephrine and levo-arterenol. Because of the high titer of epinephrine in the circulating blood, the administration of cyclopropane is contraindicated. Ether or nitrous oxide-ether is the agent of choice.

SYMPATHECTOMIES

Thoracolumbar sympathectomy involves much the same considerations as operations upon the adrenals, particularly during the second stage of the operation. Endotracheal anesthesia is always employed because during the operation the pleura is regularly entered, either purposely or accidentally

Lumbar sympathectomy like ureteral surgery or inferior vena cava ligation, requires maximum muscle relaxation Again, spinal anesthesia is the choice. The level must be carried relatively high on the side operated upon, reaching to at least the sixth thoracic dermatome.

SURGERY OF THE EXTREMITIES

Operations upon the extremities produce fewer anesthesia problems than most other procedures since this type of surgery usually has fewer systemic effects Adequate anesthesia is obtainable with light planes of general anesthesia or by simple blocks of the more accessible nerves.

Minor procedures require only local infiltration or regional field block. For more extensive procedures in the lower extremities it is well to employ spinal anesthesia Nerve blocks about the elbow or knee and about the wrist or ankle also have a useful place, but they tend to be more time-consuming to perform and less positive in their results.

Major amputations for degenerative vascular disease are performed mostly on the lower extremities. These patients have circulatory insufficiency with or without an associated metabolic disease Under such circumstances spinal anesthesia is preferred.

MANAGEMENT OF THE PATIENT DURING SURGERY

The choice of anesthesia and the method of administration are governed first by what is safest for the individual patient. During surgery the safety of the patient should continue to be the primary concern of the anesthesiologist. Most fatalities which occur during or immediately after anesthesia and which can be ascribed solely to the anesthesia are due to asphyxia. The term *asphyxia* indicates both oxygen lack and carbon dioxide excess. This may be caused by (1) failure to supply sufficient oxygen or failure to eliminate carbon dioxide properly because of defects in the anesthetic apparatus; (2) inadequate ventilation from respiratory obstruction, diminished intercostal and diaphragmatic activity, or failure to ventilate the patient artificially; (3) associated pulmonary disease that interferes with the gaseous exchange between the blood and the pulmonary alveoli; (4) the presence of anemia or diminished blood flow; (5) the inability of the tissue cells to utilize oxygen or eliminate carbon dioxide. These factors are under the control of the anesthesiologist, and he should observe them closely.

There have been instances where anesthetic gases have been accidentally attached to a machine in place of oxygen or where flowmeters or other parts have failed. Fortunately these are extremely rare accidents. More commonly it is the insidious accumulation of carbon dioxide even in the presence of adequate oxygenation that results in respiratory acidosis and a train of unphysiologic effects. Respiratory obstruction, even of a minor nature, can produce both hypoxia and hypercarbia. Obstruction should be comparatively simple to recognize and correct, but it must be realized that even though an endotracheal tube is in situ, the airway may be inadequate. Decreased tidal exchange caused by the anesthetic or by some physical impairment of the patient must be carefully assessed. Its correction by rhythmic compression of the rebreathing bag should be simple. Inadequate efforts on the part of the anesthesiologist in maintaining assisted or controlled respirations are more difficult to assess. A good rule to remember is that it is almost impossible to overventilate a patient, but it is very easy to underventilate him. The presence of pulmonary disease interfering with gaseous exchange should be revealed by the preliminary clinical evaluation of the patient. Often little can be done to correct it, but vigorous ventilation or other efforts may help to compensate for it. The patient's blood volume and hemoglobin should be brought as nearly as possible to normal before any operation is performed. The anesthesiologist must carefully replace blood as it is lost during the operative procedure. In general, surgeons underestimate blood loss and anesthesiologists overestimate it.

The relation of asphyxia, usually partial, to the occurrence of cardiac arrest cannot be overemphasized. So-called vagovagal and other types of reflexes probably have little effect on the heart of a well oxygenated patient who is not suffering from respiratory acidosis. Careful and constant observation of the patient and reporting immediately to the surgeon the cessation of the pulse and the blood pressure are important, but even more important is the prevention of cardiac stoppage. In the event that cardiac arrest does occur, the well ventilated patient will be able to withstand the circulatory standstill with less rapid deterioration, since the tissues will have no oxygen debt or carbon dioxide excess. Not least important is the fact that in such instances the heart will respond more readily to resuscitative measures.

Cessation of the heartbeat usually has prodromal signs and frequently follows other significant events such as unreplaced blood loss or respiratory difficulty, active or passive. The actual interruption of the circulation must be recognized immediately, since normal brain tissues can withstand complete lack of blood flow for only about four minutes. It is in the early detection of the actual stoppage of the circulation that mechanical diagnostic aids may be of some benefit.

There must be no hesitation on the part of the surgeon or, if necessary, the anesthesiologist, to open the chest and institute effective manual massage of the heart as soon as the diagnosis of cardiac arrest is made. The massage must be sufficient to move enough blood through the vital centers to support life. Equally important is the necessity for the concomitant administration of a sufficient amount of oxygen to the lungs. This is usually done by rapid intubation of the trachea and artificial ventilation with 100 per cent oxygen. However, if equipment for endotracheal intubation is not immediately at hand, ventilation should be started with the conventional anesthesia mask. Once proper ventilation and circulation have been established, there should be no

further deterioration of the vital brain centers. Then other well recognized agents and methods for restoring efficient circulation may be employed in a comparatively leisurely manner.*

POSTOPERATIVE CARE AND OBSERVATION

Observation of the patient in the immediate postoperative period is a comparatively new aspect of the practice of anesthesiology. This aspect has always been implied, but it has been spelled out only in the past few years. The one person responsible for the care of the patient and the one who is able to make a proper and comprehensive assessment of the physiologic state of the patient is the anesthesiologist. He has seen the patient preoperatively, he has managed the patient during the anesthesia and the operation, and he should therefore possess the background of knowledge necessary to manage the patient properly during the immediate and precarious postoperative period. This control of the patient is effected best within the confines of a postoperative *recovery room*, where the patient has the benefits of all the concentrated talents available in the hospital and also of all the equipment necessary for the proper handling of any emergency that may occur. It is a fact that better service can be offered to the postoperative unconscious patients who are gathered in one area where all of the facilities necessary for their care are located than if these same patients were distributed throughout the various floors in the hospital.

In the immediate postoperative period the care of the surgical patient, whether in a special recovery area or in a private room or ward bed, is of great importance. The character of the respirations and the adequacy of the circulation should be carefully observed.

A most common and serious postoperative complication is interference with respiration. This may occur as a result of an obstruction of the upper respiratory passage by relaxed tissues which are no longer supported by an artificial airway. Obstruction also may be due to edema of the glottis secondary to endotracheal intubation. Tracheal collapse producing respiratory obstruction has occurred following the removal of an enlarged thyroid gland for a benign or a malignant condition. More commonly respiratory obstruction is due to retained viscid secretions and to aspirated vomitus. Whatever the cause of obstruction of the air passages may be, prompt recognition and correction are most important. Furthermore, the desirability of a tracheostomy should always be considered. All too frequently this operation is performed too late. Usually if one is in doubt as to the wisdom of doing a tracheostomy, it most likely should be done. It is much better to err by doing the tracheostomy too early than by waiting until it is too late.

In a patient who is restless and apprehensive postoperatively, particularly when there is an associated hypertension, one should assume hypoxia as the cause until it is proved otherwise. Too frequently opiates are administered to quiet the patient instead of investigating the causes of the restlessness. Sedation should be administered sparingly to the postoperative patient and preferably by the intravenous route to observe more closely its effect. Even then it should be given only after all efforts have been made to insure the adequacy of the respiratory exchange and the absence of a distended urinary bladder.

The pulse and blood pressure should be recorded at stated intervals and carefully observed for any untoward fluctuations. If hypotension should occur, the patient should be examined to determine the cause. This may be secondary to an inadequate replacement of blood or to cardiac failure, vasomotor instability, a sudden decrease in a previously elevated carbon dioxide level in the blood, or to rough handling in moving or changing the position of the patient. The factor or factors which are responsible should be promptly recognized and corrective treatment prescribed.

Finally, the postoperative care of the patient includes strict attention to other details such as infusions and transfusions, observations for allergic reaction to drugs or to blood, and the care of the nasogastric tube and suction siphonage apparatus as well as of water seal drainage systems employed following intrathoracic procedures. Furthermore, inspection of the wound dressing for hemorrhage should also be made. Most of this type of care is the responsibility of the members of the surgical staff rather than the anesthesiologist. The importance of attention to details in the satisfactory postoperative recovery of the patient cannot be too strongly emphasized.

* For a scientific and practical discussion of the subject of cardiac arrest, see the monograph on Cardiac Resuscitation by Robert Hosler.

RIGHT PARAMEDIAN INCISION

A The location of the incision in the lower part of the abdomen is depicted by the dotted line.

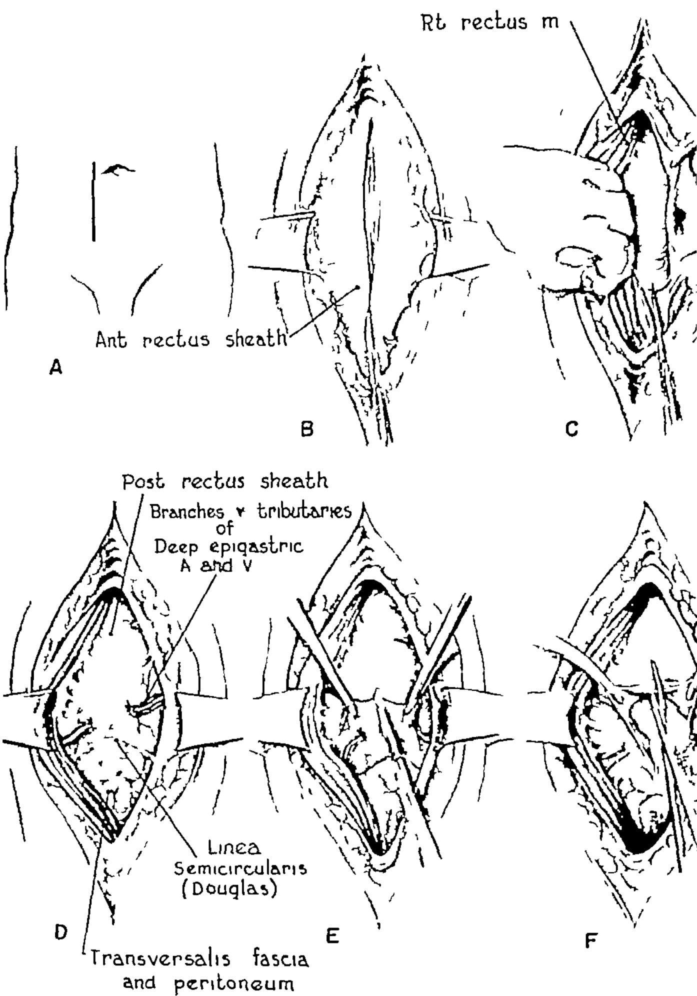
B. The incision is deepened through the subcutaneous fatty tissue layer and the wound margins are retracted to expose the line of incision in the anterior sheath of the rectus fascia.

C. The medial cut margin of the anterior rectus sheath is grasped by clamps and upward traction is maintained. The mobilized portion of the rectus muscle is displaced laterally by manual retraction overlying a moist gauze pad, and the medial border of the lower portion of the rectus muscle is separated from its midline attachments by scalpel dissection.

D The right rectus muscle is retracted laterally to expose the underlying related structures as labeled

E. The surgeon and the first assistant "pinch up" small segments of the posterior rectus sheath and peritoneum preparatory to severance with a scalpel.

F The incision into the peritoneal cavity is made, and the cut margins of the posterior rectus sheath and peritoneum are grasped in clamps. A segment of a moist gauze sponge is inserted beneath the peritoneum for protection of the underlying bowel, and the incision is extended upward by scissor dissection.


Rt rectus m
Ant rectus sheath
A
B
C
Post rectus sheath
Branches & tributaries of Deep epigastric A and V
Linea Semicircularis (Douglas)
D
E
F
Transversalis fascia and peritoneum

G The upward extension of the incision is completed and its downward extension is commenced by scalpel dissection. Here a scalpel is preferred because it does not require the surgeon to assume an awkward position of the arm and hand as is required when scissors are employed.

H The opening into the peritoneal cavity is completed, and the related underlying intraperitoneal viscera are visible.

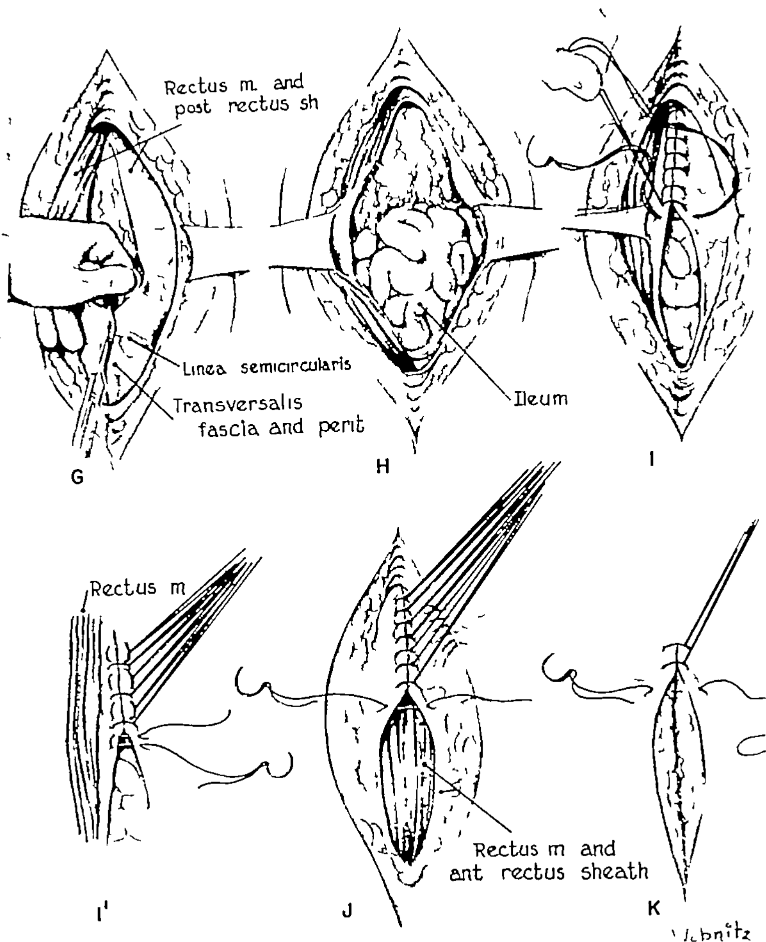
I I The posterior rectus sheath and peritoneum are sutured with either a continuous interlocking double strand suture of 00 chromic catgut (I) or a series of interrupted everting mattress sutures alternating with simple interrupted sutures of 00 silk (I')

J The rectus muscle is returned to its normal position, and the closure of the anterior rectus sheath is partially completed using interrupted sutures of silk (00). Thus the muscle acts as a buttress interposed between the lines of closure of the peritoneal and fascial layers.

K The closure of the skin with interrupted sutures of 000 silk completes the operation.

The proclaimed advantage of this incision is that it does not predispose to nerve injury and resulting muscle atrophy Furthermore, interposition of the muscle layer between the lines of closure of the anterior and posterior rectus sheaths is considered an additive support to the security of the wound closure. This incision is used almost routinely for operations in both the upper and lower portions of the abdomen, and it is highly recommended.

Plate 2


Rectus m and
post rectus sh
Linea semicircularis
Transversalis
fascia and perit
Ileum
G
H
I
Rectus m
Rectus m and
ant rectus sheath
I'
J
K

BATTLE-JALAGUIER-KAMMERER-LENNANDER INCISION

A. The incision overlying the outer third of the infraumbilical portion of the right rectus muscle is shown by the solid line.

B C. The incision is deepened through the anterior rectus sheath, and the lateral border of the rectus muscle is manually displaced medially as the mobilization of its lower portion is completed by scalpel dissection.

D The lateral border of the right rectus muscle is retracted medially to show the intercostal nerves, the linea semicircularis and, in the lower portion of the wound, the deep epigastric vessels and a branch and tributaries from the same to the posterior belly of the right rectus muscle.

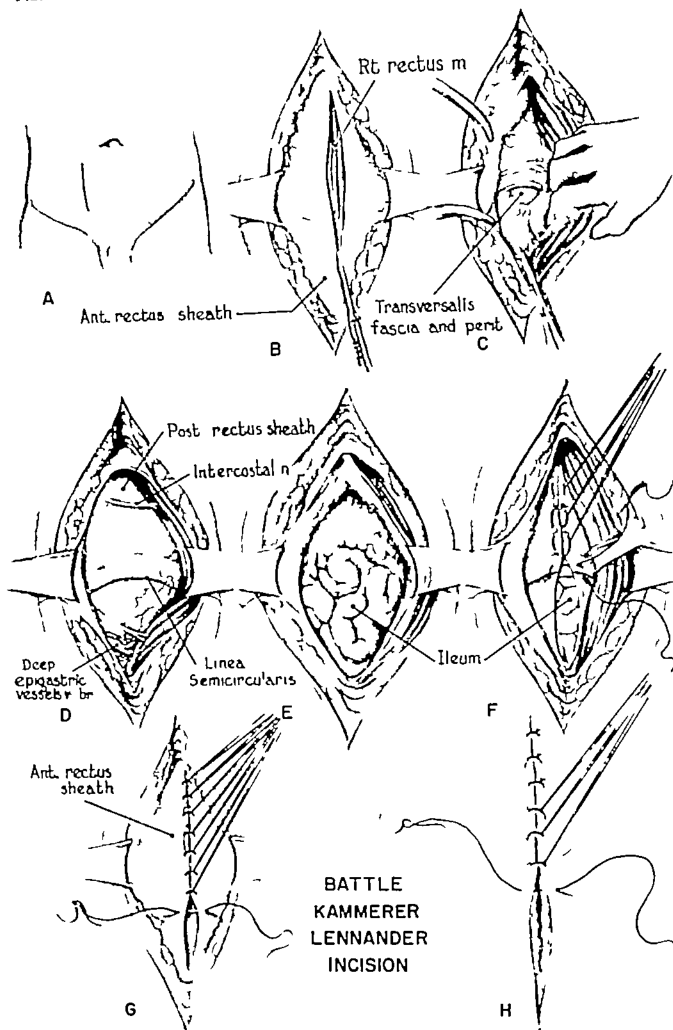
E. The opening in the peritoneal cavity is completed, and the wound margins are retracted to expose the underlying intraperitoneal viscera.

F Closure of the incision is commenced by suture of the fascia peritoneal layer by everting mattress sutures of silk (00)

G H To complete the wound closure the rectus sheath (G) and the skin (H) are approximated with interrupted sutures of 00 and 000 silk respectively

Although frequently used, the objection to this incision is the necessity for interrupting the nerve supply to the segment of the rectus muscle that is exposed in the field of operation. This causes an atrophy of the muscle and the resulting weakness of the abdominal wall theoretically predisposes to the occurrence of a postoperative ventral hernia.

Plate 3


Rt rectus m
A
Ant. rectus sheath
B
Transversalis fascia and perit
C
Post rectus sheath
Intercostal n
Deep epigastric vessels & br
Linea Semicircularis
Ileum
D
E
F
Ant. rectus sheath
BATTLE
KAMMERER
LENNANDER
INCISION
G
H

McBURNEY INCISION

A. The outline of the incision and McBurney's point are indicated. McBurney's point is located 4 cm. from the anterior superior iliac spine on an imaginary line drawn from the umbilicus to the anterior superior iliac spine. The incision, traversing McBurney's point, extends in an oblique direction one third above and two thirds below the plane of this line

B C D The incision is deepened through the fibers of the external oblique muscle and its aponeurosis and the internal oblique and transversus abdominis muscles. In the separation of the fibers in the plane between the internal oblique and transversus abdominis muscles, caution must be observed to avoid an avulsion injury of the intercostal nerves which are depicted in D

E. Small segments of the transversalis fascia and peritoneum are tented by tissue forceps preparatory to being incised transversely with a scalpel.

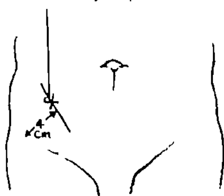
F The peritoneal cavity is entered, and the wound margins are retracted to expose the ileocecal region and the appendix.

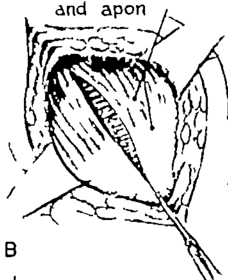
G The fascia-peritoneal layer is closed using interrupted everting matress sutures of silk (000).

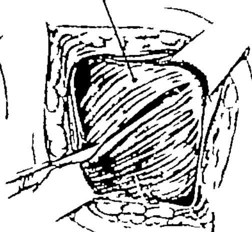
H I The separated margins of the transversus abdominis, internal oblique, and external oblique muscles are approximated loosely with interrupted sutures of 000 silk.

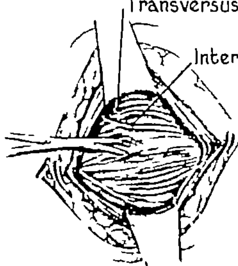
J The closure of the skin with interrupted sutures of silk (000) completes the operation.

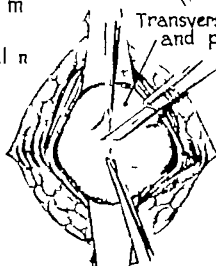
This incision is considered most anatomic and conducive to less trauma because exposure is obtained by separation of the muscles in the direction of their fibers. There is also less likelihood of injury to the nerve supply of the muscles. It is believed that this incision, though widely used and recommended by many is employed too routinely and, as a consequence, operative exposure may frequently prove inadequate. It is particularly useful for the performance of appendectomies in young children and adult males. In women, even though the diagnosis of acute appendicitis is the most likely one a right paramedian incision is preferred. In fact, this type of incision is used rather than the McBurney regardless of the age and sex of the patient. Although the McBurney incision has been advocated, particularly for the drainage of intraperitoneal abscesses, no difficulty has occurred when similar drainage was required through a paramedian incision.

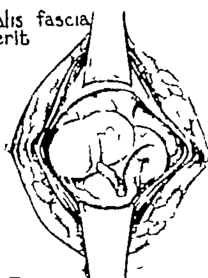


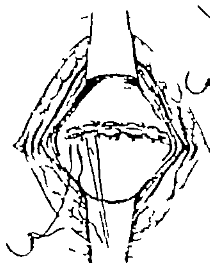


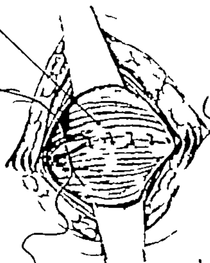


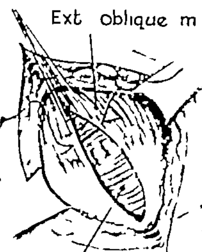














McBURNEY
INCISION

PFANNENSTIEL INCISION

A The location of the curvilinear transverse incision, with its convex border down and within the hair line of the pubes, is shown.

B. The rectus fascia is severed transversely in the same plane as the skin incision to expose portions of the rectus muscles

C. Curved clamps (Kelly) are applied to the cut margin of the upper leaflet of the rectus fascia, and, with traction maintained, this fascia is mobilized from the surface of the rectus muscles by scalpel dissection.

D The lower leaflet is similarly dissected downward, and the separated medial borders of the rectus muscles are retracted laterally and the fascia peritoneal layer is opened longitudinally with a scalpel to enter the peritoneal cavity

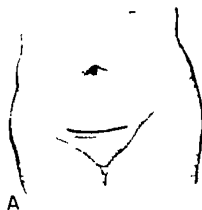
E. The opening into the peritoneal cavity is completed, and the wound margins are retracted to expose the pelvic and related viscera.

F The closure of the fascia peritoneal layer is almost completed using continuous interlocking double strand suture of 00 chromic catgut.

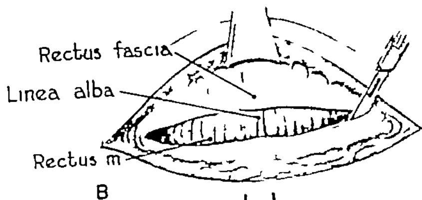
G The medial margins of the rectus muscles and the rectus fascia are sutured with interrupted sutures of 00 silk.

H. The operation is completed by closure of the skin incision with interrupted sutures of 000 silk. Sutures are not inserted in the subcutaneous fatty tissue layer regardless of the depth of this particular layer

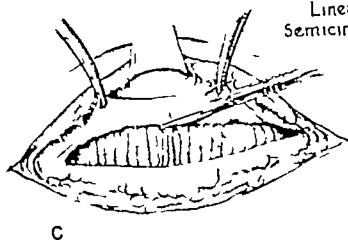
Plate 5



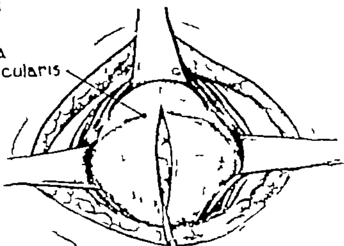
A



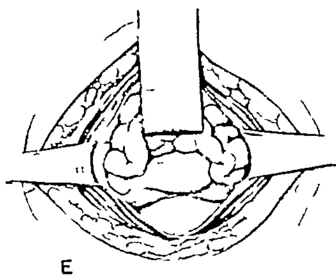
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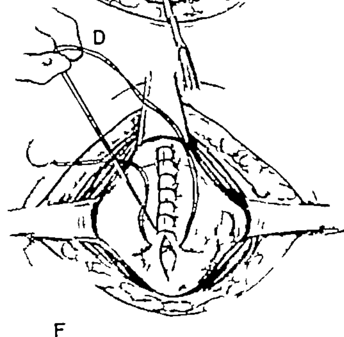
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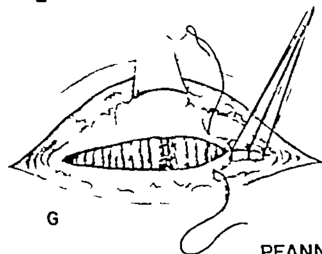
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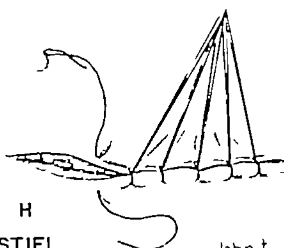
E



F



G



H

PFANNENSTIEL
INCISION

SUBCOSTAL (KOCHER) INCISION

A The extent and location of the incision in relation to the right costal margin is demonstrated.

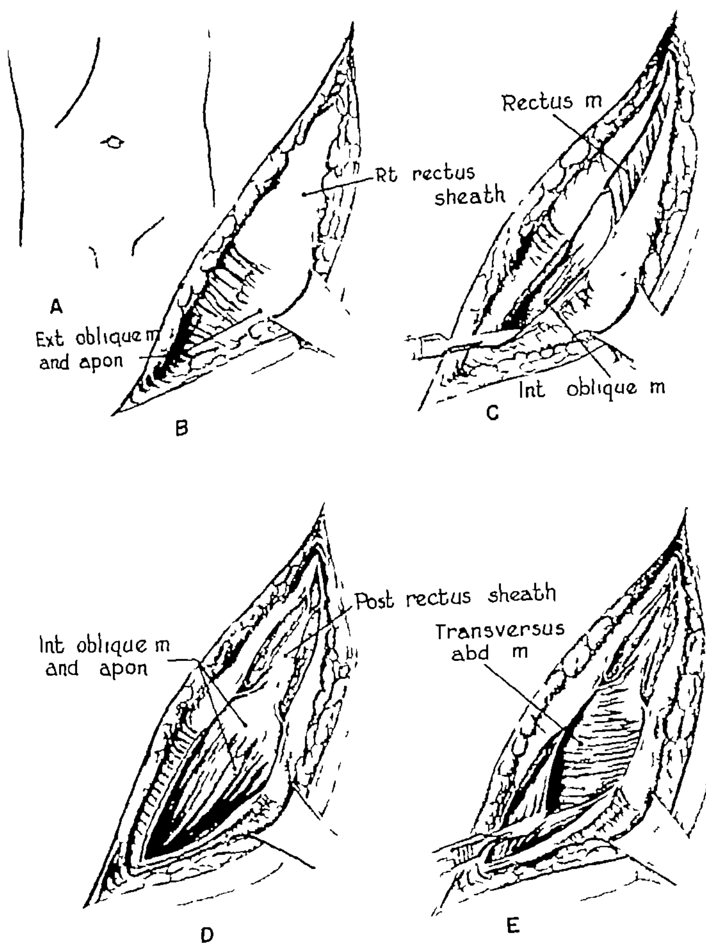
B. The incision is deepened through the subcutaneous fatty tissue layer and the underlying structures are depicted.

C. The anterior rectus sheath is incised, and the incision is continued laterally through the aponeurosis and fibers of the external oblique muscle.

D The rectus muscle is transected, and the internal oblique muscle and its aponeurosis are exposed.

E. The aponeurosis and the fibers of the internal oblique muscle are severed, and the relation of the posterior lamella of the aponeurosis of the internal oblique muscle and the fascia of the transversus abdominis in the formation of the posterior rectus sheath may be seen.

Plate 6



SUBCOSTAL (KOCHER) INCISION

F The incision is extended through the posterior rectus sheath, the transversus abdominis muscle, and the peritoneum to expose the underlying intraperitoneal viscera.

G Closure of the incision is commenced by the suturing of the transversus abdominis muscle and the underlying peritoneum laterally and the posterior rectus sheath and underlying peritoneum medially with interrupted sutures of silk (00) If desired, closure with the use of a continuous suture of chromic catgut, or interrupted figure of 8 or everting mattress sutures of silk (00), may be employed.

H. The internal oblique muscle and its aponeurosis and the anterior rectus sheath are approximated with interrupted sutures of 00 silk

I. The closure of the external oblique muscle and its aponeurosis and the anterior rectus sheath is completed using interrupted sutures of 00 silk.

J In the closure of the skin, a series of small straight (Cambric) needles are all first inserted, then withdrawn individually and the sutures tied. These sutures may be cut either individually after they are tied or after they have all been first inserted and tied.

This incision is one of the most popular in use for operations upon the biliary tract. Nevertheless, the preference of the author is a longitudinal oblique paramedian muscle-retracting (lateral) incision as depicted in the illustrations of the technic for cholecystectomy

Transversus abd muscle and perit
Stomach
Gall bladder
Transversus abd m

F

G

Rectus m
Rectus sheath
Int. oblique m
Ext oblique m

H

I

J

KEHR INCISION

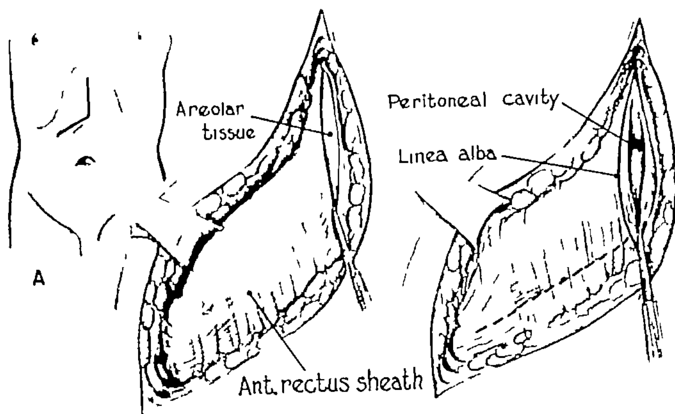
A The skin incision is commenced in the midline at the level of the tip of the xiphoid process and extends vertically downward to a point approximately midway between the xiphoid and umbilicus. It is then directed obliquely lateralward to terminate just beyond the outer border of the right rectus muscle

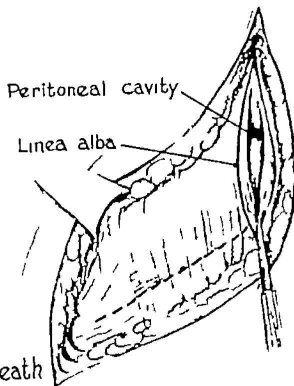
B. The incision is deepened through the subcutaneous fatty tissue plane and the line of fascia fusion of the rectus sheaths (linea alba) is incised.

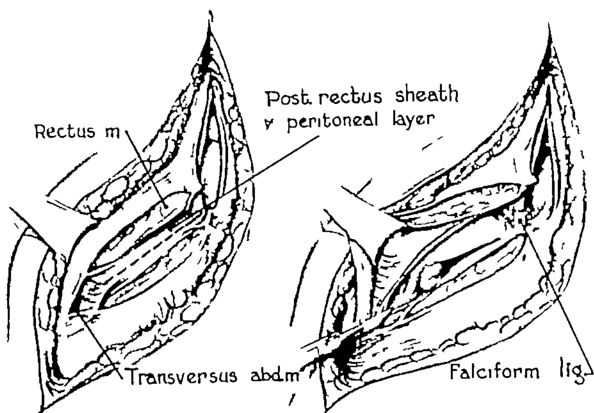
C. The underlying properitoneal fatty areolar tissue layer and peritoneum are incised, and the peritoneal cavity is entered. Usually one or two vessels in the areolar tissue layer are clamped, severed, and ligated, using ligatures of fine (0000) silk. The direction of the incision for transection of the anterior rectus sheath and the underlying rectus muscle is indicated by the dotted line.

D The transection of the rectus muscle is completed, and the line of incision in the posterior rectus sheath is demonstrated (dotted line)

E. The incision is completed into the peritoneal cavity and it is extended laterally by partial severance of the fibers of the transversus abdominis muscle The falciform ligament is doubly clamped and severed at the site indicated by the dotted line







KEHR
INCISION

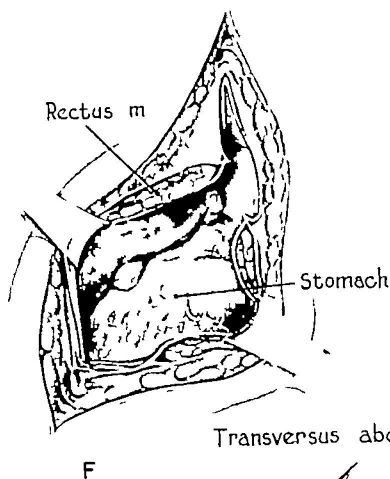
F The incision is completed, and the adequacy of the exposure obtained is demonstrated.

G Closure of the incision is commenced by suturing the peritoneal and fatty areolar tissue layers in the midline and continuing the closure in an obliquely transverse direction to approximate the posterior rectus sheath and peritoneum. A continuous interlocking double strand suture of 00 chromic catgut is used. However if preferred, interrupted everting mattress sutures of silk (00) may be employed.

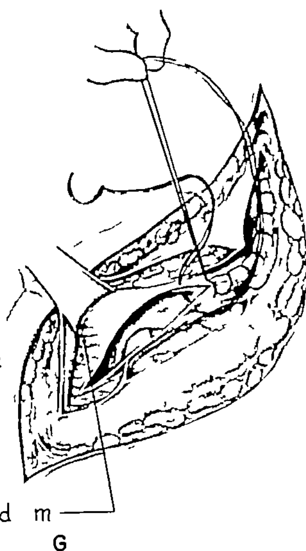
H I. The fascia and skin layers are approximated using interrupted sutures of 00 and 000 silk respectively

The particular advantage of this type of incision in operations upon the gallbladder and bile ducts has been recently emphasized by Holman.

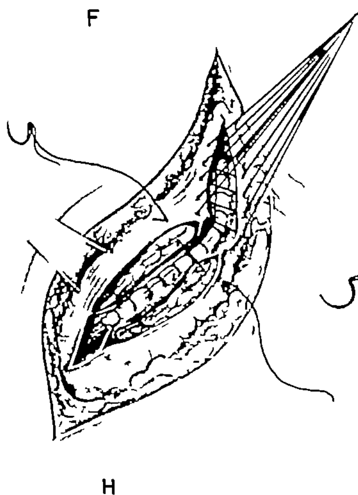
Plate 9



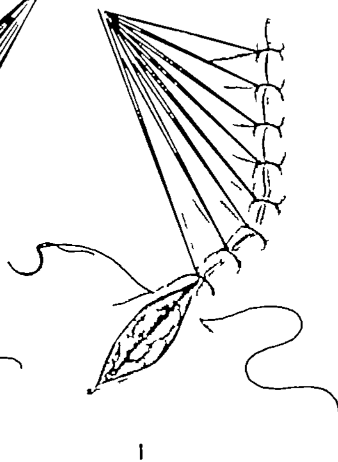
F



G



H



I

Wabnitz

A. The incision commences in the costoxiphoid angle and extends downward to a level approximately 1 inch below and lateral to the umbilicus. Just above the umbilicus, a transverse extension of the incision is made which is directed lateralward to form a modified T shaped pattern. In the original article in which this incision is described, it is shown on the right rather than on the left side as illustrated.

B. The incisions through the subcutaneous fatty tissue layer are completed, and the anterior sheath of the rectus is incised longitudinally in the left paramedian plane.

C. The transection of the left rectus muscle is completed, and the musculofascial flap is retracted upward to expose the costal arch and a portion of the transversus abdominis muscle The opening into the peritoneal cavity is visible

D The main portion of the costal arch and its related costal cartilages are severed with a scalpel preliminary to retraction of the costal arch.

E. The fascia, peritoneum, and the transversus abdominis muscle are severed in a horizontal plane and the musculochondral flap is retracted upward to complete the operative exposure.

This incision is used only rarely in modern surgery An advantage proclaimed for this type of incision was that one could obtain maximum exposure for surgery within the upper portion of the abdomen without entering into the pleural cavity However in present-day surgery there is not the same fear of entrance into the pleural cavity Accordingly abdominal incisions may be extended into the thoracic cavity when this is required to obtain more adequate exposure. Therefore, the use of the compromise type of incision described by Marwedel would be rarely required.

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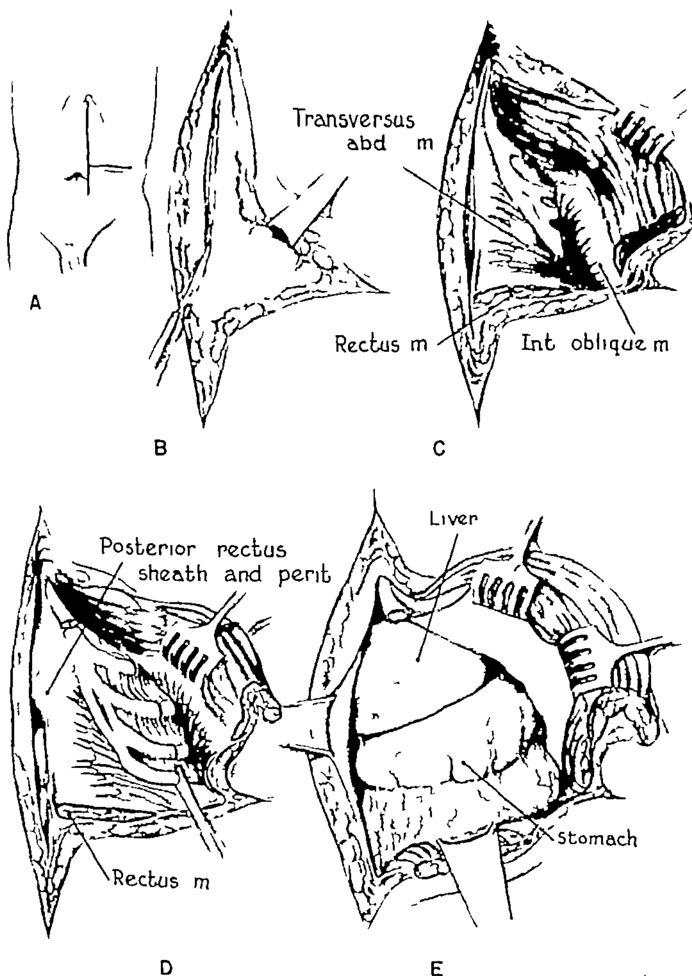
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MARWEDEL INCISION

Discussion—Dr. Raymond P Sullivan Abdominal incisions require careful consideration by the surgeon for adequate exposure and in anticipation of a safe and satisfactory closure. Improper incisions contribute to additional time consumption and may add to the surgical risk. An adequate incision permitting free access to the abdominal contents will always prove not only safer but conducive to less trauma and more efficient teamwork. The choice of abdominal incision is primarily a matter for the surgeon s consideration of the physiologico-anatomic *factors in* such a way as to avoid mutilation of the abdominal wall. It should always be borne in mind that any incision is safest when anchored to the fundamental rules of asepsis, hemostasis, adequate exposure, and team work. These are the important factors of safety which contributed so much in the development of surgery after the introduction of anesthesia and the transition from antiseptic to aseptic technic.

In the upper portion of the abdomen the Kocher subcostal incision as illustrated is used for lesions of the gallbladder bile ducts, pancreas, duodenum, and on occasions for resection of the colon. It is not a physiologic incision because it cuts obliquely the underlying musculature of the anterolateral abdominal wall and consequently injuries two or three of the intercostal nerves. However it is believed less harmful than other forms of nonphysiologic incisions. In place of this type of incision, especially in the obese patient, the incision described by James Masson (Plate 11 A2) is believed more satisfactory especially if lower abdominal exploration is necessary This incision extends obliquely downward from the tip of the xiphoid to a point immediately below and 2 to 3 cm. lateral to the umbilicus. The anterior rectus sheath is severed and the fibers of the rectus muscle are split longitudinally at the junction of its inner and middle thirds. The posterior rectus sheath and peritoneum are then incised longitudinally and the peritoneal cavity is entered.

The longitudinal paramedian incision which is shown may also be used in the upper abdomen. However when it is used and drainage is deemed necessary this should be done through a lateral stab wound opening as suggested by Fred Lund. This enables the surgeon to obtain a complete closure of the original wound and lessens the predisposition to the occurrence of a postoperative incisional hernia. This type of incision is always preferred to one of the midline type.

Still another incision, available in place of the Kocher incision, would be the one described by Mayo-Robson (Plate 11 B1) which is frequently referred to as the hockey stick incision. The Bevan (Plate 11 A1 B2) modifications of this incision may prove equally useful. Furthermore, a transverse incision including the skin, fascia, muscle, and peritoneum gives excellent exposure and easy access to all of the upper abdominal contents. It may be employed in operations upon the stomach, pancreas, liver bile ducts, and spleen. It is an incision which is the least likely to injure nerves and blood vessels and, accordingly it is less apt to be associated with the occurrence of an incisional hernia.

The Marwedel incision as depicted provides an excellent exposure for operations upon the liver stomach, spleen, hepatic flexure, transverse colon, and splenic flexure. This incision gives ready access to the subdiaphragmatic space and may be particularly useful in the performance of total excision of the stomach.

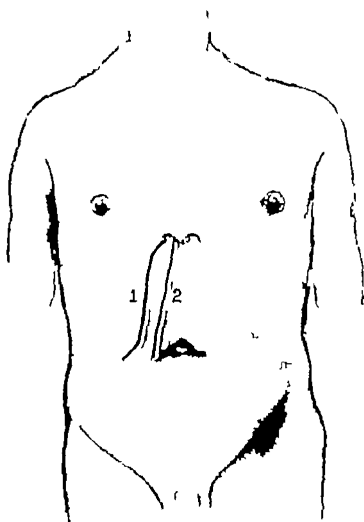
The Kehr incision as demonstrated was designed particularly for operations on the gallbladder and bile ducts. It gives excellent exposure but is not believed as physiologic as some of the others previously described. It is a type of incision which requires *minute attention to detail* in the closure of the wound in order to obtain satisfactory union.

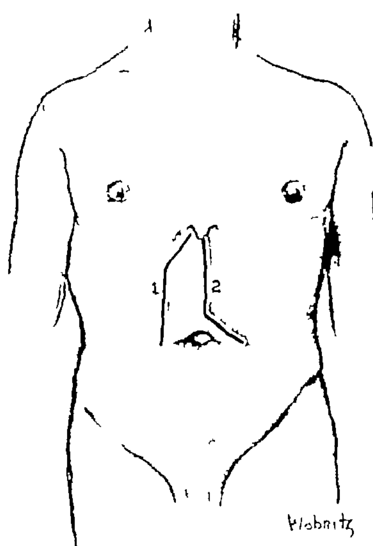
In the lower abdomen, the incision that is probably the most frequently used is the one described by Mc Burney This incision is most physiologic because it does not cause injury to nerves, muscles, or blood vessels, and, therefore, theoretically it is less likely to result in the occurrence of a postoperative incisional hernia. It is primarily indicated for appendectomy cecostomy and drainage of lower quadrant abscesses. However this type of incision limits the opportunity for really adequate exploration, and, furthermore, if the appendix is fixed either in the pelvis or high in the retrocecal position, the necessity for enlargement of the incision may make the operation more difficult technically To obtain better exposure the incision may be extended by the method described by Weir—the transection of the rectus sheath and either retraction or severance of the underlying rectus muscle.

The Battle-Kammerer-Lennander incision as shown in the drawings is preferred to the gridiron type, especially in adults or in the obese patient. This type of incision may be extended readily when necessary for more adequate exposure in the performance of a general exploration or to do a bowel resection. However in children when there is little doubt of the diagnosis of appendicitis, the McBurney type of incision is routinely employed.

The Pfannenstiel lower abdominal incision is used principally in gynecologic surgery This incision is not strictly a physiologic one because at this level the fusion of the aponeuroses of the internal oblique and transversus abdominis muscle enters into the formation of the anterior sheath only Hence the longitudinal part of the incision posterior to the rectus muscles is confined chiefly to the transversalis fascia and the peritoneum.

Regardless of the type of incision that the surgeon may employ either in the upper or lower portion of the abdomen, attention to detail relative to hemostasis and prevention of tissue trauma should always be of prime consideration. Tissues should be handled with the utmost gentleness and minimal amounts of tissue should be grasped in the hemostatic forceps. Ligatures and suture ligatures of fine silk or fine cat gut are preferred. The peritoneal cavity should not be entered until hemostasis in the wound layers is complete. Sterile towels are fixed to the skin margins, and the application of moist laparotomy pads to the sides of the wound will not only protect against trauma but will aid in the control of capillary oozing. *If the surgeon is diligent about these necessary details* and accordingly is "kind to the tissues," the tissues will be in turn "kind to the surgeon" and healing of the wound per primam will be the expected outcome.





A

1 BEVAN INCISION "OLD"

2 MASSON INCISION

B

1 MAYO-ROBSON INCISION

2 BEVAN INCISION "NEW"

THE THORACOABDOMINAL INCISION

The thoracoabdominal incision either right or left, is of distinct value if used when properly indicated. It converts the pleural and the peritoneal cavities into one main cavity and thereby gives excellent exposure of the operative area. However closure of the wound is time-consuming and there is a predisposition to more frequent postoperative complications. Furthermore, it is believed that this type of incision is employed too frequently as a routine when either an abdominal or a thoracic incision alone would suffice for the operation that is planned.

The right thoracoabdominal incision, as depicted in the artist s illustrations, may be particularly useful in reconstructive operations upon the common duct, total excision of the right lobe of the liver and shunt operations between the portal vein and the inferior vena cava. The left thoracoabdominal incision may be used effectively in resections of the lower end of the esophagus, total gastrectomy the removal of large and adherent spleens, and in the performance of shunt operations between the splenic and the left renal veins.

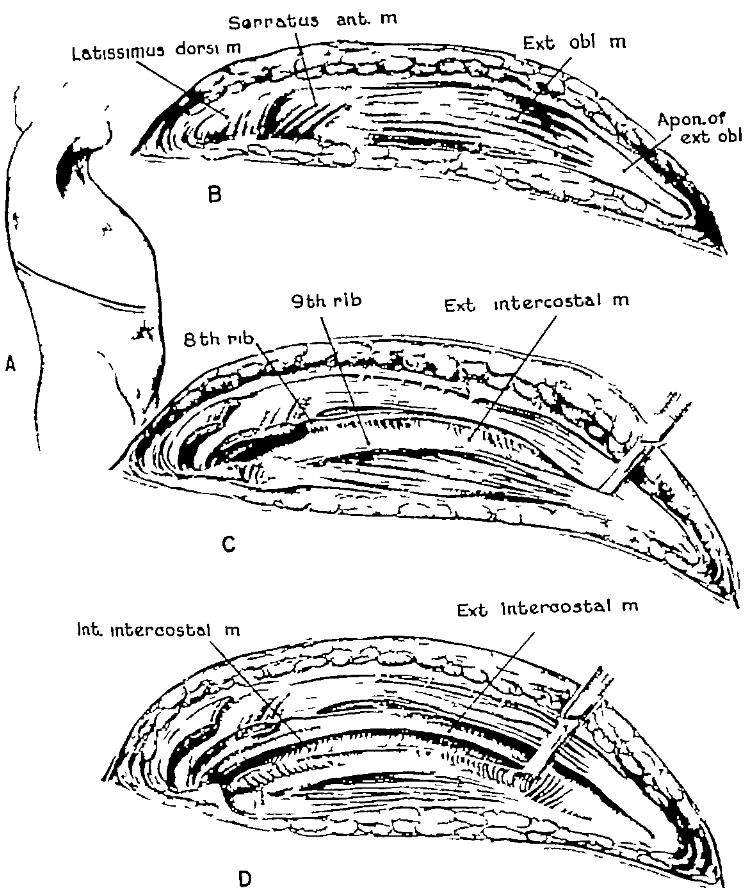
A. The incision overlying the eighth interspace and extending across the right costal margin onto the anterior abdominal wall is shown.

B. The incision is deepened through the skin and the subcutaneous fatty tissue layers to expose the underlying musculature of the anterolateral thoracic and the anterior abdominal walls.

C. The exposed muscles—the latissimus dorsi, the serratus magnus, and the external oblique muscle and its aponeurosis—are severed with a scalpel to expose the eighth and ninth ribs and the intervening external intercostal muscle.

D The incision is continued through the external intercostal muscle layer and the fibers of the internal intercostal muscle which course in a different plane are depicted.

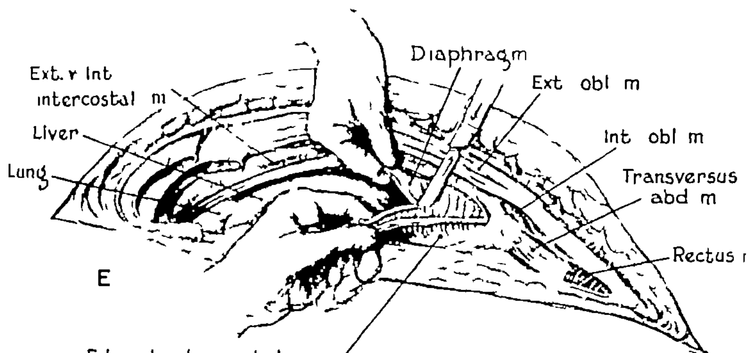
Plate 12

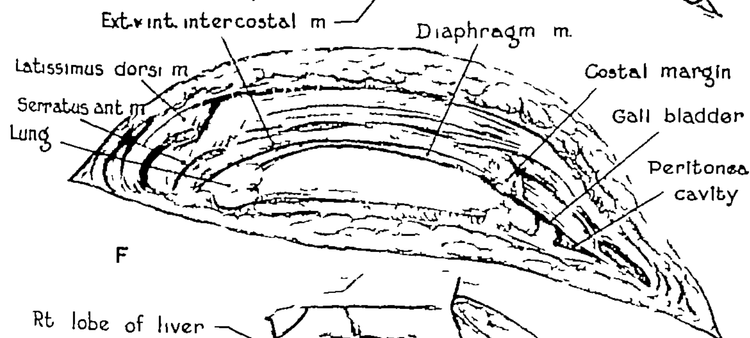

Serratus ant. m
Latissimus dorsi m
Ext obl m
Apon. of ext obl
B
A
9th rib
Ext intercostal m
8th rib
C
Ext Intercostal m
Int. intercostal m
D

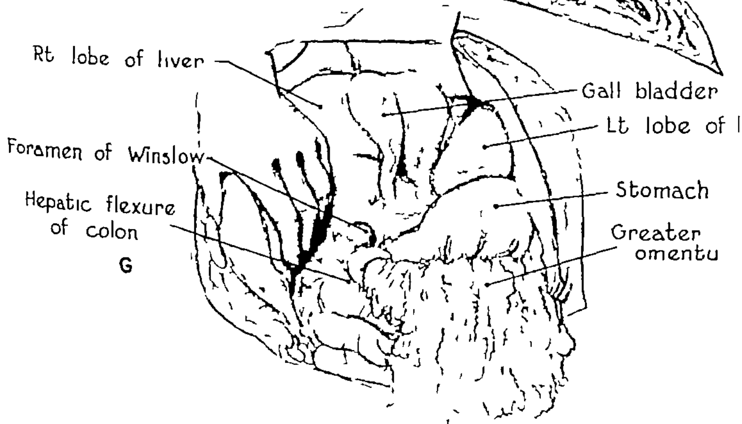
E. The incision is deepened posteriorly through the internal intercostal muscle, the endothoracic fascia, and the parietal pleura to enter the right pleural cavity. This incision is then extended anteriorly to the costal arch severing the fibers of the internal intercostal muscle and the underlying fibers of the right leaflet of the diaphragm.

F. The incision is continued across the costal arch and through the musculature of the anterior abdominal wall to enter the peritoneal cavity.

G. The incision is completed, and the adequacy of the exposure of the operative field obtained by the conversion of the pleural and peritoneal cavities into a common cavity is shown.


Diaphragm
Ext. & Int intercostal m
Ext obl m
Liver
Int obl m
Lung
Transversus abd m
Rectus r
E
Ext. & int. intercostal m

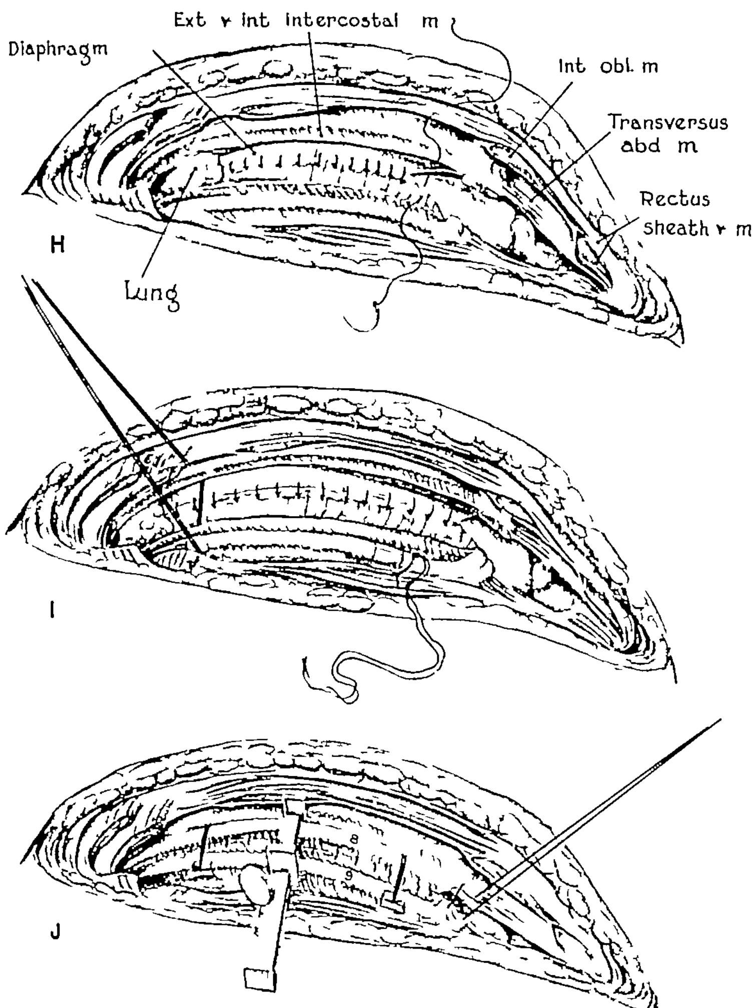

Diaphragm m.
Latissimus dorsi m
Costal margin
Serratus ant m
Gall bladder
Lung
Peritonea cavity
F


Rt lobe of liver
Gall bladder
Lt lobe of l
Foramen of Winslow
Stomach
Hepatic flexure of colon
Greater omentu
G

E. The incision is deepened posteriorly through the internal intercostal muscle, the endothoracic fascia, and the parietal pleura to enter the right pleural cavity. This incision is then extended anteriorly to the costal arch severing the fibers of the internal intercostal muscle and the underlying fibers of the right leaflet of the diaphragm.

F. The incision is continued across the costal arch and through the musculature of the anterior abdominal wall to enter the peritoneal cavity.

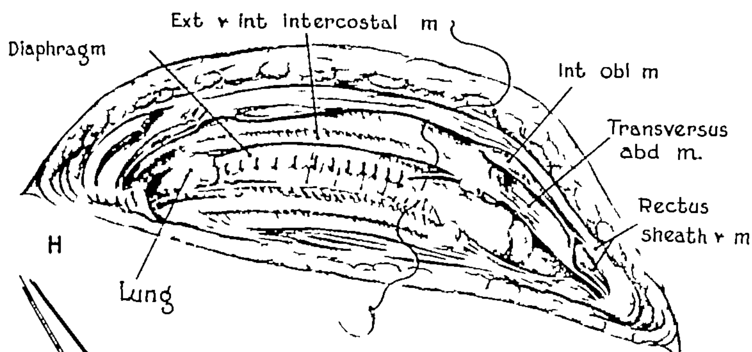
G. The incision is completed, and the adequacy of the exposure of the operative field obtained by the conversion of the pleural and peritoneal cavities into a common cavity is shown.


Ext & int intercostal m
Diaphragm
Int obl. m
Transversus abd m
Rectus sheath & m
H
Lung
I
8
9
J

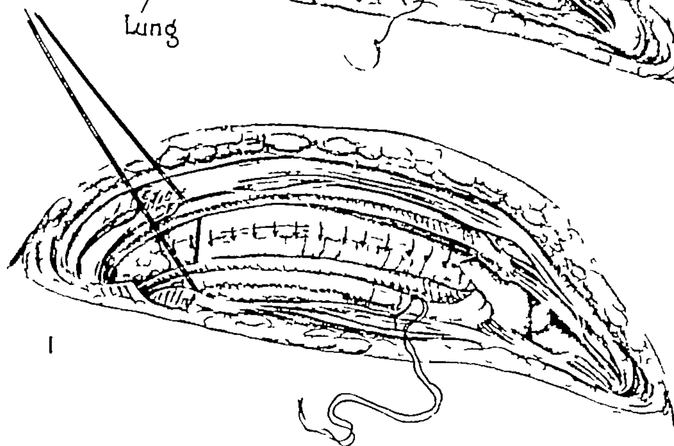
H The closure of the incision is begun by the approximation of the cut margins of the diaphragm with interrupted sutures of silk (00). The surrounding related structures are *indicated.*

I Two pericostal sutures of double strands of No 2 chromic catgut are inserted preliminary to the approximation of the eighth and ninth ribs. Prior to the insertion of these sutures periosteal "windows" are made along the inferior border of the lower or ninth rib This is done to prevent the impingement of the sutures upon the periosteum and thereby possibly lessen both the incidence and/or the severity of post thoracotomy pain.

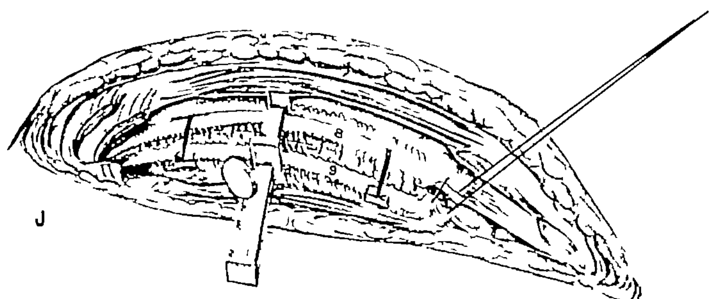
J The rib cage is approximated with a self retaining Bailey–Gibbons rib approximator and the pericostal sutures are tied and cut. The sutures of silk (000) in the intercostal muscle layers are first inserted and, after approximation of the ribs they are then tied and cut. A figure of 8 mattress suture of No 1 braided silk is inserted to unite the cut margins of the costal arch.



Ext & Int intercostal m
Diaphragm
Int obl m
Transversus abd m.
Rectus sheath & m
H
Lung



I



8
9
J

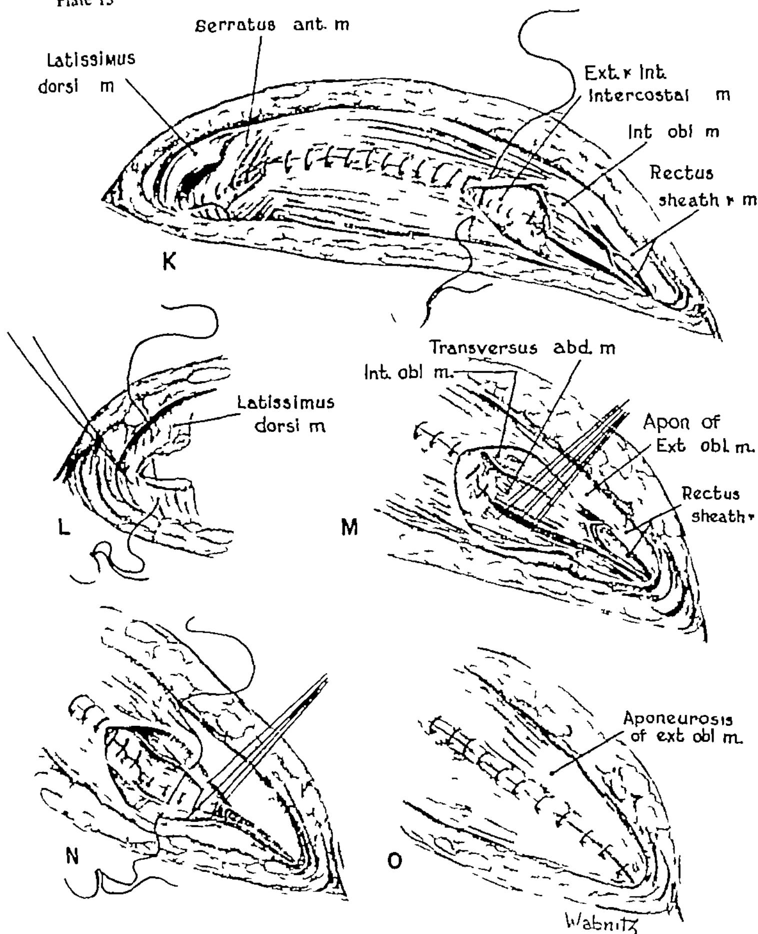
K. The closure of the rib cage is completed, and the cut margins of the serratus anterior and the external oblique muscles are sutured with interrupted sutures of silk (00).

L. Close up showing the approximation of the severed fibers of the latissimus dorsi muscle with interrupted silk (00) sutures.

M The transversus abdominis muscle layer is approximated with a series of interrupted sutures of silk (000), which are shown inserted but not tied

N The closure of the transversus abdominis muscle is completed, and the suturing of the internal oblique muscle is begun using sutures of silk (000)

O The closure of the muscle layers is completed by suturing the aponeurosis of the external oblique muscle and the anterior rectus sheath Although not illustrated in the drawings, water seal drainage of the pleural cavity is routinely employed.


Serratus ant. m
Latissimus dorsi m
Ext. & Int. Intercostal m
Int obl m
Rectus sheath & m
K
Latissimus dorsi m
L
Transversus abd. m
Int. obl m.
Apon of Ext obl. m.
Rectus sheath &
M
N
Aponeurosis of ext obl m.
O
Wabnitz

THE POSTEROLATERAL THORACIC INCISION

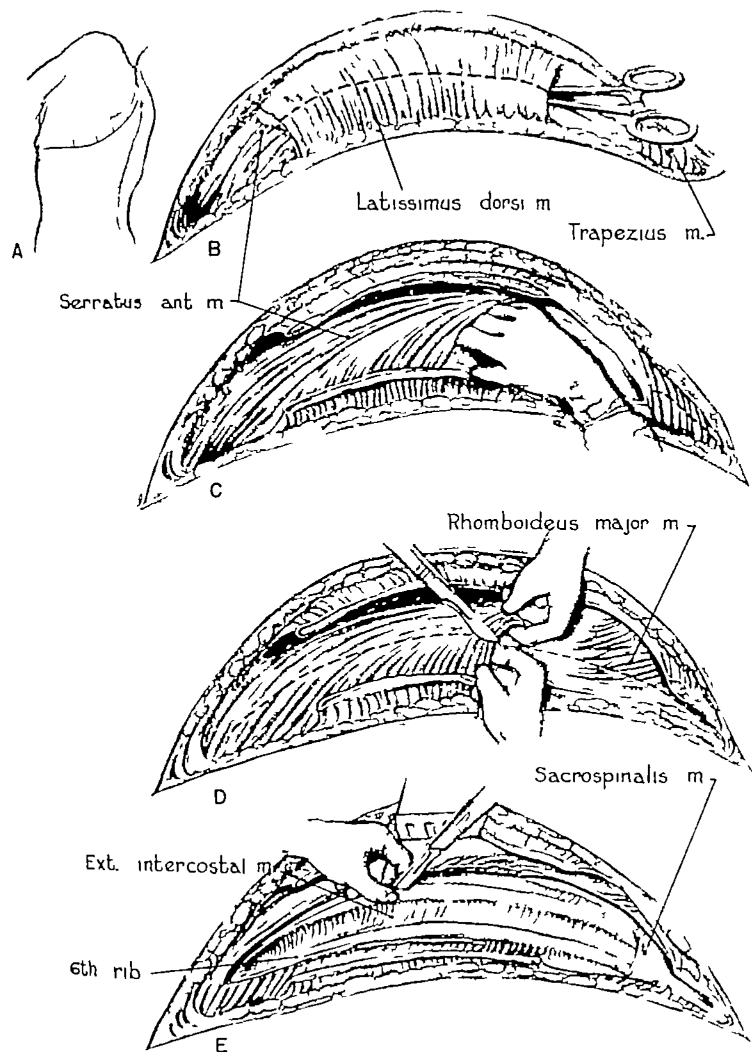
A. The curvilinear posterolateral incision, extending from the anterior axillary line, posteriorly and upward, to a point midway between the vertebral border of the scapula and the thoracic spine, is outlined and crosshatched to facilitate later closure

B. The latissimus dorsi muscle is mobilized by blunt gauze dissection, and the line of transection of its fibers is indicated by the dotted line.

C. The transection of the latissimus dorsi muscle is completed, and the right hand of the surgeon is inserted upward beneath the mobilized portion of the serratus anterior muscle to identify the fifth rib In this maneuver the uppermost rib readily palpable is the second. The site of severance of the trapezius muscle is depicted by the dotted line.

D The fifth rib is identified, and the fibers of the serratus anterior muscle overlying this rib are severed with a scalpel as demonstrated. To avoid minor technical difficulties, the serratus magnus (anterior) muscle should always be severed over the length of the rib that is either mobilized or resected The site of division of the fibers of the rhomboideus major muscle and the adjacent fibroareolar tissue is indicated.

E. A portion of the rib cage and the intervening intercostal muscle layers are shown. A longitudinal incision through the periosteum overlying the exposed portion of the anterior surface of the fifth rib is begun.


A
B
Latissimus dorsi m
Trapezius m.
Serratus ant m
C
Rhomboideus major m
D
Sacrospinalis m
Ext. intercostal m
6th rib
E

The mobilized lateral border of the sacrospinalis muscle is retracted posteriorly and the angle of the fifth rib is visible.

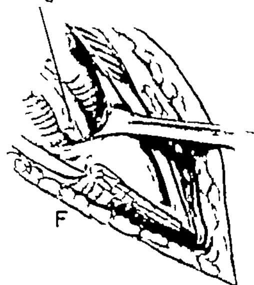
H I J The periosteum is removed from the lower half of the anterior surface of the fifth rib (G H), and the posterior surface of the rib is separated from the subjacent endothoracic fascia and parietal pleura by both instrumental (I) and digital (J) dissection. The dissection in the plane beneath the rib is continued cephalad under the fourth and third ribs respectively This method, originally described by Sir Russel C. Brock of England, permits free mobility of the rib cage and obviates the need of performing a rib resection. Furthermore, transection of the related intercostal muscle layers is unnecessary These muscle layers, the external and internal intercostals and the accompanying neurovascular bundle remain intact and are an aid in securing an air tight closure of the chest wall

K. The fifth rib is rotated upward, and the incision in the subjacent parietal pleura is extended posteriorly by scissor dissection.

L_1 L_2 L_3. These illustrations depict the formation of periosteal "windows" to prevent the impingement of the pericostal sutures upon the periosteum in an attempt to lessen the incidence of post thoracotomy pain.

L_4 The closure of the incision is commenced by the insertion of multiple pericostal sutures consisting of double strands of No 2 chromic catgut.

Angle of 5th rib











5th rib

Lung

K

Parietal pleura

Sacrospinalis m.

L1

L2

L3

L4

Intercostal muscle bundle

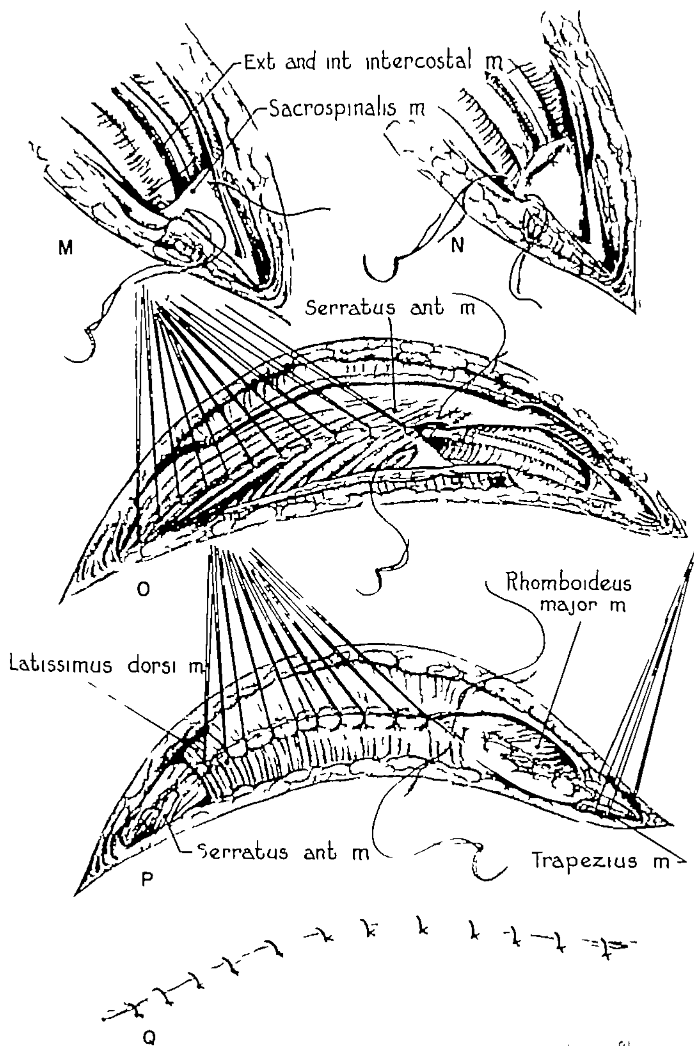
6th rib

Trapezius m

M N. The pericostal sutures are tied, and the overlap of the lower half of the anterior surface of the fifth rib by the subjacent intact intercostal muscle layers is visible. To secure an air tight closure of the pleural cavity the lateral margin of the sacrospinalis muscle is approximated to the subjacent intercostal muscle layers with a mattress suture of 00 silk (M) and two simple interrupted sutures of 00 silk (N).

O The approximation of the rib cage is completed, and the severed fibers of the serratus anterior and the rhomboideus major muscles are sutured with interrupted sutures of 00 silk

P Q The latissimus dorsi muscle and the fibroareolar tissue layer overlying the "angle of auscultation" between this muscle and the trapezius muscle, and the transected fibers of the trapezius muscle are sutured with interrupted sutures of 00 silk (P) The skin layer is closed with interrupted sutures of 000 silk (Q) Although not demonstrated, in all thoracic incisions in which an entrance into the pleural cavity is made, water seal drainage of the pleural cavity is routinely employed


Ext and int intercostal m
Sacrospinalis m
M
N
Serratus ant m
O
Rhomboideus major m
Latissimus dorsi m
Serratus ant m
Trapezius m
P
Q

THE ANTERIOR THORACIC INCISION

A. The right inframammary curvilinear incision, extending from the midline of the sternum to the right midaxillary line, is depicted.

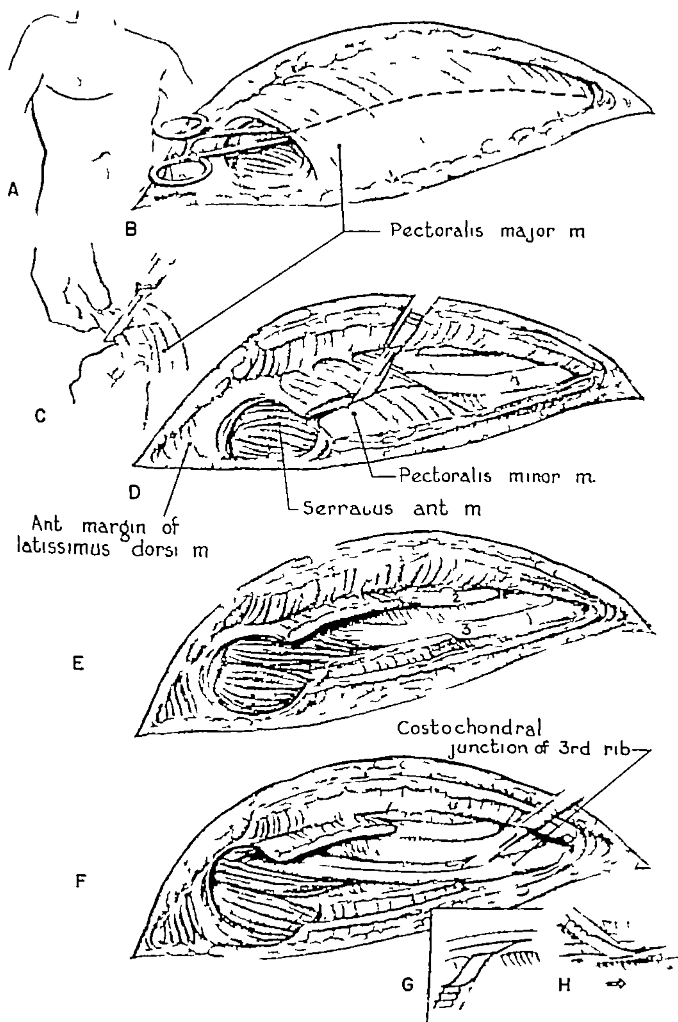
B. By blunt dissection with a pledget of gauze on a ring clamp the pectoralis major muscle is separated from the underlying pectoralis minor muscle, and the proposed line of transection of its fibers is shown by the dotted line

C. Close up to show the compression of the fibers of the pectoralis major concomitant with their severance This particular technic is considered a valuable adjunct in the prevention of excessive blood loss Intermittent release of the digital compression permits the visualization of bleeding points within the muscle which are clamped as the severance of the muscle fibers proceeds.

D The fibroareolar tissue layer overlying the serratus anterior muscle is divided, and the transection of the fibers of the pectoralis minor muscle is begun with a scalpel.

E. The transection of the pectoralis major and minor muscles is completed, and the underlying second and third ribs and the intervening external intercostal muscle layer are visible.

F G H A longitudinal incision is made through the periosteum overlying the third rib (F), and the lower half of the incised periosteum is separated from the inferior border of the rib with a periosteal elevator (G H)


A
B
Pectoralis major m
C
D
Pectoralis minor m.
Serratus ant m
Ant margin of
latissimus dorsi m
2
3
E
Costochondral
junction of 3rd rib
F
G
H

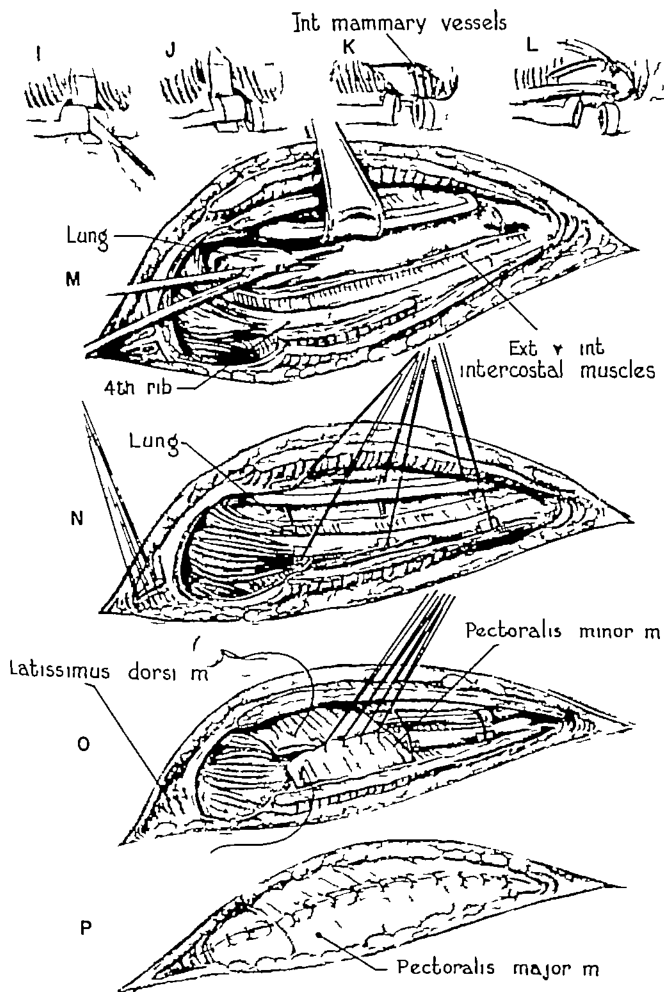
I J K L. A subperichondrial resection of a small segment (2 cm.) of the cartilage of the third rib is done (I J), and the adjacent internal mammary vessels are doubly clamped and severed preliminary to ligation with ligatures of 00 silk (K, L)

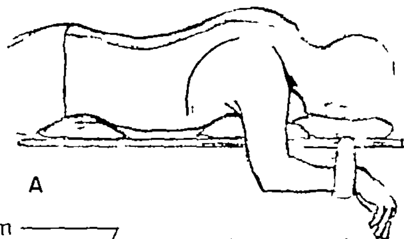
M. The mobilization of the third rib is completed, and the detached but intact external and internal intercostal muscle layers and the related neurovascular bundle are shown The third rib is retracted upward and the opening into the right pleural cavity is extended anteriorly by scissor dissection.

N In the closure of the incision, double strands of No 2 chromic catgut are inserted through periosteal "windows" along the inferior border of the fourth rib as pericostal approximating sutures The severed fibers of the latissimus dorsi muscle are united with interrupted sutures of silk (00).

O The rib cage is approximated by tying the previously inserted pericostal sutures, and the transected fibers of the pectoralis minor muscle are sutured with interrupted sutures of 00 silk. In the approximation of the rib cage, the intact intercostal muscle layers may be seen overlying the lower half of the anterior surface of the third rib

P The fibroareolar tissue layer and the cut margins of the pectoralis major muscle are sutured with interrupted sutures of 00 silk. In this approach, as in all other types of thoracic incisions, water seal drainage of the pleural cavity using a No 16 Foley catheter is routinely performed.


Int mammary vessels
I
J
K
L
Lung
M
Ext & int
intercostal muscles
4th rib
Lung
N
Pectoralis minor m
Latissimus dorsi m
O
P
Pectoralis major m
Wabnitz



A

Trapezius m

Latissimus dorsi m

Rhomboideus major m

Sacrospinalis m

5th rib

External intercosta

Serratus ant m

B

C

D

Pectoralis major m

THE POSTERIOR (PRONE) THORACIC INCISION

A. The position of the patient and the outline of the incision are shown.

B. The latissimus dorsi muscle is mobilized by blunt gauze dissection, and the direction for transection of the fibers of this muscle is indicated.

C. Bleeding points in the severed margins of the latissimus dorsi muscle are clamped and the clamps are subsequently replaced by suture ligatures of 000 silk. The exposed portion of the trapezius muscle is severed and the intact serratus anterior and rhomboideus major muscles are visible.

D. The fibers of the serratus anterior and rhomboideus major muscles are severed, the mobilized lateral border of the sacrospinalis muscle is retracted posteriorly and the line of incision in the periosteum overlying the anterior surface of the fifth rib is shown. This incision extends from a point 3 to 4 cm. beyond the angle of the rib anteriorly to the midaxillary line.

DISCUSSION—DR. CHARLES B. RIPSTEIN. *Anterior Incision.* The chief advantages of this incision are speed, ease of closure, and minimal disturbance of respiratory and circulatory function. It also has the minor advantages of not interfering with scapular muscles and of having an excellent cosmetic scar.

The anterior incision can be used for resections of most segments of the lung, although lower lobe segments may be difficult to expose. It is useful in cardiac surgery, and particularly good exposure is obtained when a combined right and left anterior incision are joined by a transverse sternal incision.

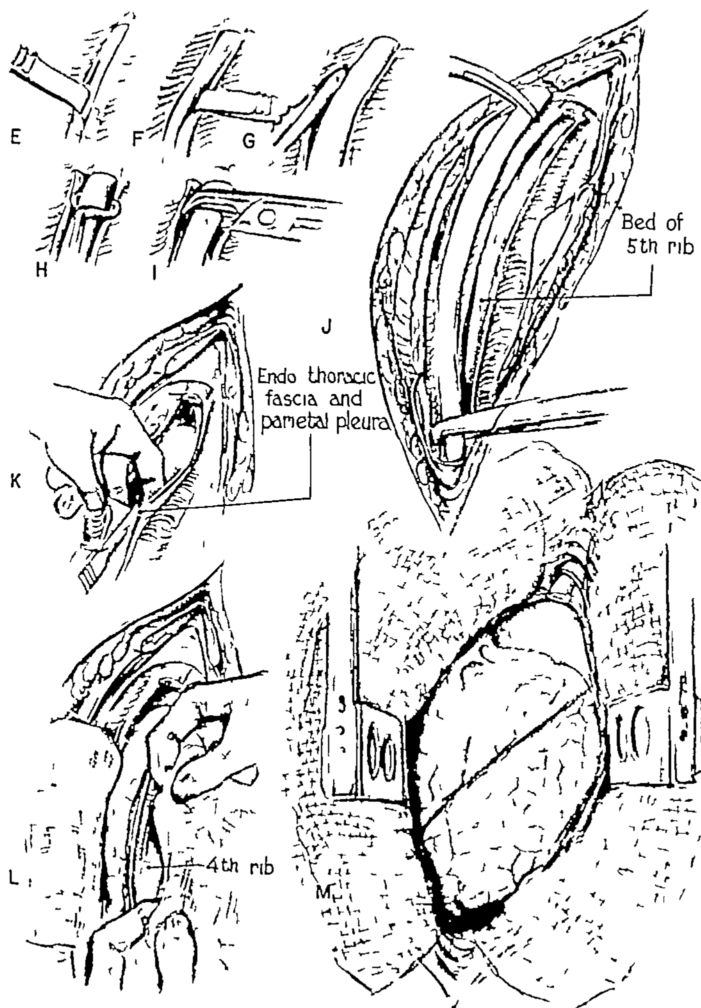
I have used this incision with complete satisfaction in a wide variety of thoracic procedures. Exposure can be widened by combining a unilateral anterior incision with a vertical sternal-splitting incision.

In the illustration, a right anterior thoracic incision is shown. I prefer to elevate the chest to a 45 degree angle with a sandbag and suspend the arm from the ether screen. The submammary skin incision is usually extended upward in the midline. There is no advantage to resecting a rib in this incision, such a maneuver leaves a large defect anteriorly and does not provide added exposure. If the latissimus dorsi is mobilized laterally and the fibers of the serratus anterior are split in the desired intercostal space, a wide exposure can be obtained.

Closure can be accomplished with interrupted sutures as illustrated or, alternatively, with a continuous suture. In females, when the breast has been elevated from the chest wall, a submammary drain is advisable to prevent a collection in the submammary space. I feel strongly that, although it is not shown, intercostal tube drainage to an underwater seal is mandatory in all thoracotomies.

Posterolateral Incision. This is the standard thoracotomy incision in most clinics. It offers the widest exposure for unilateral lesions. Its only disadvantage is the dependant position of the nonoperated side which makes respiratory exchange more difficult in poor risk patients. Where high exposure is required, the posterior limb of the incision must be extended into the parascapular area and the scapula mobilized by dividing the trapezius and rhomboid muscles. This step is not necessary if the chest is entered below the sixth rib.

The illustrations show resection of the sixth rib, but this incision may enter the chest anywhere from the third to the tenth rib. Removal of a rib is optional. This is seldom necessary in children where wide re-


E
F
G
H
I
J
K
L
M
Bed of
5th rib
Endo thoracic
fascia and
parietal pleura
4th rib
Wabn 73

E, F, G H I. Close up views to show the separation of the periosteum from the rib prior to its resection.

J The rib is transected posteriorly and elevated from its bed prior to its transection anteriorly

K. The right pleural cavity is entered through the bed of the fifth rib and, with a scalpel, the incision in the endothoracic fascia and parietal pleura is extended anteriorly

L, M. The rib margins and the soft tissues of the incisional wound are covered with moist gauze pads (L) and protective moist toweling (M) prior to the insertion of a self retaining rib retractor for the exposure of the intrapleural viscera. In the closure of this incision, the same basic principles of technic as previously described are followed

DISCUSSION—DR. RIPSTEIN (cont.)

traction is possible without producing fracture. In adults, I prefer to enter the chest through an intercostal space and divide the posterior portions of adjacent ribs to permit wide retraction.

Closure is well illustrated, again I recommend intercostal tube drainage.

Thoracoabdominal Incision. Combined thoracoabdominal incisions offer magnificent exposure in dealing with lesions involving lower thoracic, upper abdominal, and retroperitoneal organs. On the left side, the lower esophagus, diaphragm, stomach, spleen, colon kidney adrenal aorta, and sympathetic chain are well exposed. On the right side, the diaphragm, liver biliary tract, duodenum, vena cava, kidney and adrenal are readily accessible.

The right thoracoabdominal incision is well illustrated. The abdominal portion may be extended to the midline and the right rectus muscle completely divided to obtain maximum exposure. The details of closure are most important, and a meticulous anatomic reconstruction is desirable. I have found it advantageous to leave a covering of fascia and areolar tissue over the costal arch and to approximate the divided cartilage by fine interrupted sutures through this layer

Posterior Incisions. The advantages of this approach are two first, it permits the operated side to be dependent, an advantage when there is a great deal of tracheobronchial secretion or exudate, and second, it does not interfere with expansion of the nonoperated lung. The disadvantages are the inconvenience of posturing the patient and the inadequate exposure of certain areas in the anterior chest and mediastinum.

This incision is used chiefly in resection for tuberculosis, but it has not attained the widespread popularity of the posterolateral approach.

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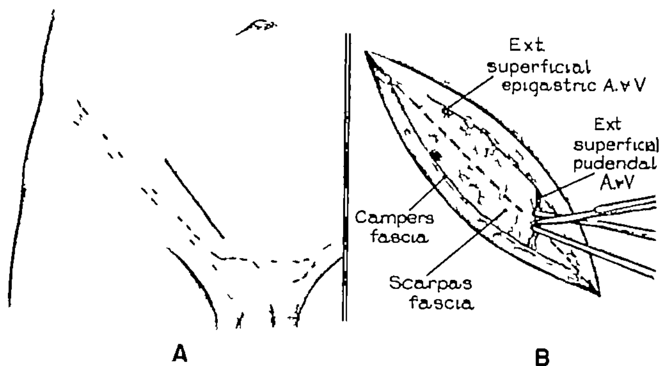
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Campers fascia
Scarpa's fascia
Fatty areolar layer
C
Aponeurosis of ext. oblique M.
D
E
Int. oblique M
Iliohypogastric Nerve
Conjoined tendon
Inguinal ligament
Cremaster M
F
Cord
G
Ilioinguinal Nerve

HERNIORRHAPHY—INDIRECT INGUINAL HERNIA

A. An oblique inguinal incision approximately 6 cm. in length and about 3 cm medial and parallel to the inguinal ligament is outlined and crosshatched to facilitate later closure. The proximal end of this incision extends to a point midway between the pubic tubercle and the anterior iliac spine. The extension of the incision to the level of the anterior iliac spine, so frequently depicted, is not necessary

B. The skin incision is deepened through the superficial layer (Camper) of the subcutaneous fascia to expose the vessels between this layer and the underlying deep layer (Scarpa) of the subcutaneous fascia. The external superficial epigastric vessels have been doubly clamped, severed, and occluded with ligatures of fine (0000) silk. The external superficial pudendal vessels are being severed between clamps with a scalpel. The incision to be made through Scarpa's fascia is in dotted outline

C. An incision is made through the fatty areolar tissue layer beneath Scarpa's fascia to expose the underlying aponeurosis of the external oblique muscle.

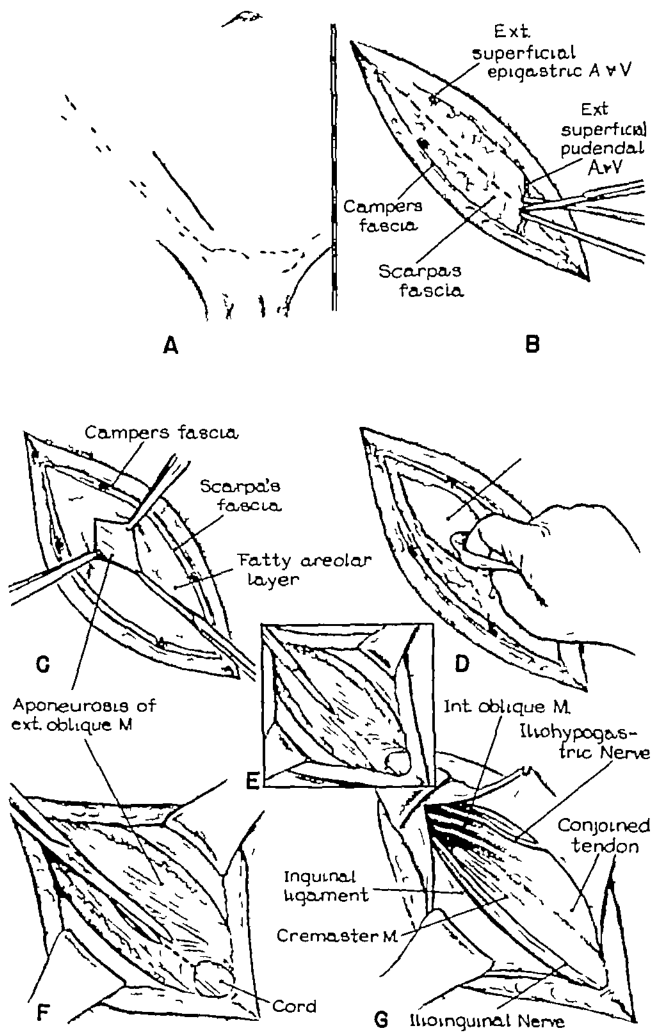
D The fatty areolar tissue layer is most easily separated from the aponeurosis of the external oblique muscle by blunt digital dissection with a piece of dry gauze over the index finger

E, F A small incision is made with a scalpel through the external oblique aponeurosis, and the incision is extended downward by scissor dissection through the external ring.

G The medial and lateral leaflets of the aponeurosis are mobilized and retracted to expose the structures as depicted

DISCUSSION—DR. S. W MOORE. When incisions are crosshatched (Plate 23 A) to facilitate closure, usually the cross marks are not accurately approximated and at times leave an unsightly scar The incision may be accurately approximated by insertion of the middle suture first, one bite of which it may be necessary to place lower on one side than on the other In general incisions for hernias are placed too far laterally It is believed that the incision should extend well over the pubic spine as this is the location where the repair is to be performed.

It is the practice of some surgeons not to remove the fatty areolar tissue from the fascia (Plate 23 O) since it is believed that this is an important source of blood supply Personally however I prefer to have the fascia as clean as possible In the illustration, Plate 23 G the ilioinguinal nerve is clearly shown. Normally it is best to leave this nerve intact, but if it should interfere with the repair it may be severed without any ill effect.


Ext. superficial epigastric A & V
Ext superficial pudendal A & V
Campers fascia
Scarpas fascia
A
B
Campers fascia
Scarpa's fascia
Fatty areolar layer
C
D
Aponeurosis of ext. oblique M
E
Int. oblique M.
Iliohypogastric Nerve
Conjoined tendon
Inguinal ligament
Cremaster M
Cord
F
G
Ilioinguinal Nerve

O The ligated stump of the hernial sac, retracted beneath the internal oblique muscle is shown in dotted outline The external spermatic and pubic vessels and their parent trunk, the deep epigastric vessels, are clearly shown. In the closure of the V-shaped defect in the transversalis fascia, the two uppermost silk (000) sutures are anterior and the remaining sutures posterior to the external spermatic and pubic vessels.

P The closure of the defect in the transversalis fascia with interrupted sutures of silk (000) is completed. The external spermatic and pubic vessels have their exit below the two uppermost sutures. If desired a segmental resection of these vessels may be performed prior to the closure of the transversalis fascia.

Q The cremaster muscle "veil" may be loosely approximated as shown, and the medial leaflet of the external oblique aponeurosis is enfolded and sutured to the shelving edge of the inguinal ligament using interrupted sutures of silk (000). In this technic a fascia to-fascia approximation without tension is obtained. The Bassini type of repair in which the conjoined "tendon" is sutured to the inguinal ligament is not practiced. The objection to this type of repair is twofold (1) it is believed anatomically unsound and places undue tension upon the structures that are approximated (2) the conjoined tendon is most frequently not tendinous but generally a frayed musculofascial structure of limited holding power

R. The approximation of the medial leaflet of the external oblique aponeurosis to the shelving edge of the inguinal ligament is completed, and the imbrication of the lateral leaflet about the cord, using sutures of fine silk (0000) is commenced.

R Inset to demonstrate the Stetten maneuver of cutting the lateral leaflet to prevent constriction of the cord at its exit from the internal ring. Although this method is in common usage, the technic shown in R is preferred.

S. The imbrication of the lateral and medial leaflets of the external oblique is being completed. The sutures which approximated the medial leaflet of the external oblique aponeurosis to the shelving edge of the inguinal ligament may be seen as faintly visible black dots.

T U. The superficial fascia and skin layers are approximated using interrupted sutures of 0000 and 000 silk respectively

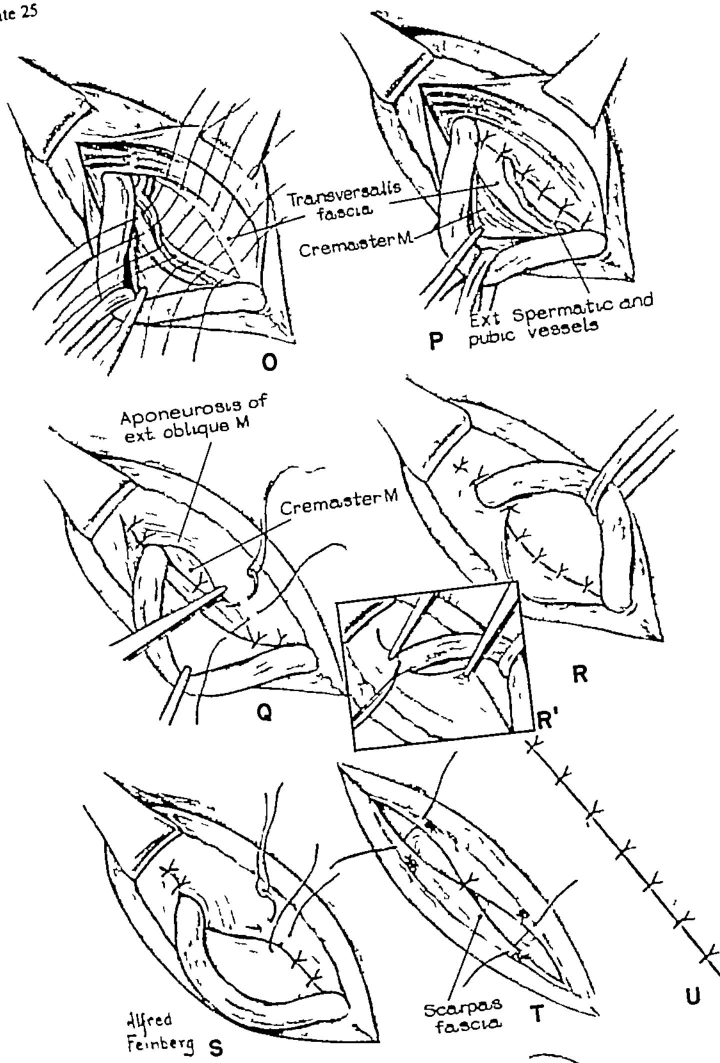
Discussion—Dr. Moore (cont.)

In repairing the defect as illustrated in Plate 25 (O) I like to get rid of as much excess tissue in the cord structures as possible in order to diminish its diameter and thereby have a small opening at its site of exit in the fascia repair Therefore all of the fat and usually the cremaster muscle is excised frequently leaving only the vas deferens and the cord vessels. At times the vas deferens and the cord vessels are separated completely and brought out through different openings in the fascial repair

In young muscular subjects I prefer the Bassini method and utilize this technic when the direct space is strong and the transversalis fascia is intact Although there are objections to the use of muscle tissue in the repair of a hernia, I have observed in secondary operations upon recurrent hernias the muscle strongly adherent to the fascia

In the Halsted I type of repair where the external ring is placed over the internal I no longer incise the lateral leaf of the external oblique aponeurosis as depicted in Plate 25 (R'), but actually make a very short inguinal canal, measuring approximately 1.5 cm. in length, between the two openings placing the external opening cephalad. When the tissues are thinned out and weakened and in instances where there have been two or more attempts at the repair of a hernia, the cord may be severed and/or the testicle removed to effect a better chance for cure

Plate 25


Transversalis fascia
Cremaster M
Ext Spermatic and pubic vessels
O
P
Aponeurosis of ext. oblique M
Cremaster M
Q
R
R'
Alfred Feinberg
S
Scarpas fascia
T
U

HERNIORRHAPHY—DIRECT INGUINAL HERNIA

A. An oblique inguinal incision 7 to 8 cm. in length, 1 inch medial to and paralleling the lower portion of the inguinal ligament is made and deepened through the underlying tissue to expose the aponeurosis of the ex ternal oblique muscle A small incision is made in the aponeurosis with a scalpel, and the incision is extended downward by scis sor dissection through the external ring as depicted by the dotted line.

B. The medial and lateral fascial flaps are retracted, and the cut margins of the in cised cremaster "veil" are held in tissue for ceps and separated to expose the direct hernial protrusion and the related struc tures.

C D E. The protrusion of the hernia is through Hesselbach s triangle medial to and below the deep epigastric vessels. This triangle is bound medially by the lateral border of the lower third of the rectus mus cle, laterally and superiorly by the deep epigastric vessels, and inferiorly by the in ner third of the inguinal ligament An inci sion is made in the transversalis fascia about the whole of the circumference of the base of the hernia and by traction on the distal cut margin the thin cap of the trans versalis fascia is inverted on itself and re moved (E).

F An incision is made through the properito neal fat to expose a portion of the hernial sac.

DISCUSSION—DR. MOORE (cont.)

In direct inguinal hernias at times it is quite diffi cult to dissect out the hernial sac. Furthermore, the bladder may constitute a large part of the hernial contents. In the direct hernia there is almost always a small indirect component present. If however there is no sac present, the peritoneum lateral to the deep epigastric vessels is usually lax and may be readily picked up in tissue forceps. In the mobili zation of the sac of a direct hernia the sac may be converted into an indirect hernia by transferring it lateral to the deep epigastric vessels and the neck of the sac occluded as described in the repair of an in direct hernia. However the direct sac usually has a neck of wide diameter and either a circular suture or a series of interrupted sutures, as previously men tioned, should be used. This method of conversion of a direct into an indirect hernia is believed to prevent damage to the bladder and avoids the error of over looking an associated small indirect hernia which is considered a frequent cause of hernia recurrence. In 1920 this technic was described in a paper presented before the New York Surgical Society by Dr Houget and is frequently referred to as the Houget maneuver

In the repair of a direct hernia, closure of the trans versalis fascia is believed one of the most important steps, and it should be done carefully and completely to prevent herniation of fatty tissue through the line of closure. I suture the conjoined tendon and the in ternal oblique muscle to the shelving edge of the inguinal or Poupart's ligament as in the Halsted I pro cedure and believe that this gives an additional sup porting layer overlying Hesselbach s triangle. Fur thermore, particular care is taken to insert sutures lateral to the cord as shown in Plate 27 (K), so that a snug closure of the internal ring is obtained.

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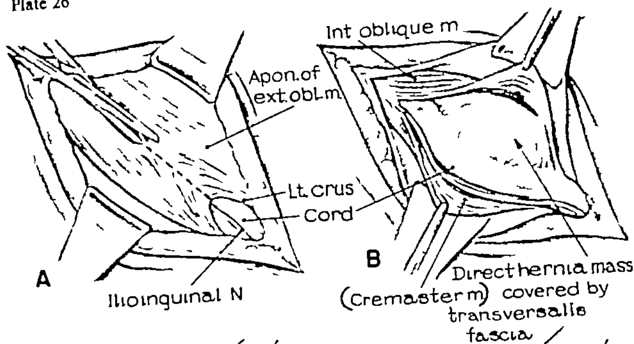
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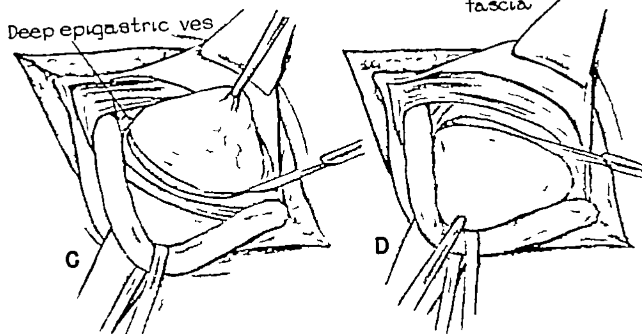
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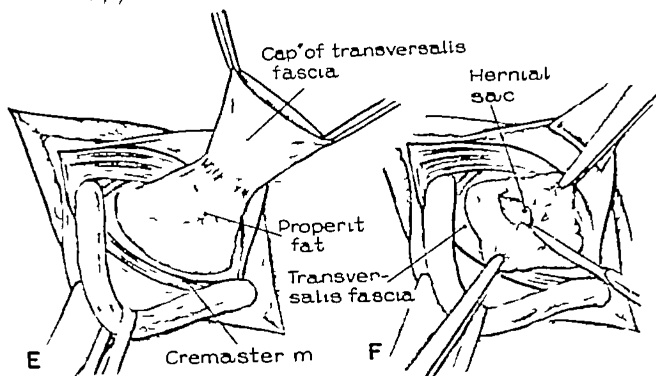
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Plate 26


Apon.of ext.obl.m
Lt.crus
Cord
Ilioinquinal N
A
Int oblique m
B
Directhernia mass covered by transversalis fascia
(Cremaster m)


Deep epigastric ves
C
D


Cap'of transversalis fascia
Properit fat
Cremaster m
E
Hernial sac
Transver-salis fascia
F

G. The mobilization of the hernial sac is continued and the bladder is separated from its medial wall by scissor dissection. In the surgical treatment of direct hernias, a common practice of many is simply to invert the hernial protrusion by a tier of plication sutures in the transversalis fascia. However when routine dissection of the sac is practiced, one is impressed with its size which is always much larger than originally anticipated. Furthermore, the basic principle in the treatment of an inguinal hernia, direct or indirect, is the excision of the sac. The inversion technic previously mentioned is a transgression of this principle and its use should be an exception rather than a routine practice

H. The mobilization of the sac is completed and *its relation to the surrounding structures* is shown. The sac is lateral to the obliterated hypogastric artery thereby conforming to the definition of a lateral direct hernia.

I. The redundant sac tissue is excised and its usually wide neck is occluded with interrupted mattress sutures of silk (000). In the closure of the neck of the sac in a direct hernia, interrupted rather than pursestring *or transfixion sutures are preferred because* of its wide diameter

I J Insets to show the completed closure of the neck of the sac (I') and the insertion of reinforcing *figure of 8 mattress sutures* in the redundant cuff of peritoneum distally (J)

J The medial and lateral layers of the transversalis fascia are approximated without tension about the external spermatic and pubic vessels using interrupted sutures of silk (000) *The cuff of the occluded neck of* the hernial sac is demonstrated in dotted outline beneath the upper portion of the transversalis fascia.

K. The medial leaflet of the external oblique aponeurosis is approximated to the shelving edge of the inguinal ligament with interrupted sutures of 000 silk. Neither the so-called conjoined tendon nor the internal oblique muscle is used in the reconstruction of the inguinal floor Furthermore, the Anson-McVay procedure utilizing Cooper's ligament, or one of its modifications, is used in the repair of only one type of direct hernia, this is depicted in the succeeding plate of illustrations.

L. The lateral leaflet of the external oblique aponeurosis is imbricated over the medial leaflet about the exit of the cord structures *This relation of the fascial closure to the* cord is not considered a mechanical weakness in the repair as some have stated. The closure of the subcutaneous tissue and the skin layers completes the operation.

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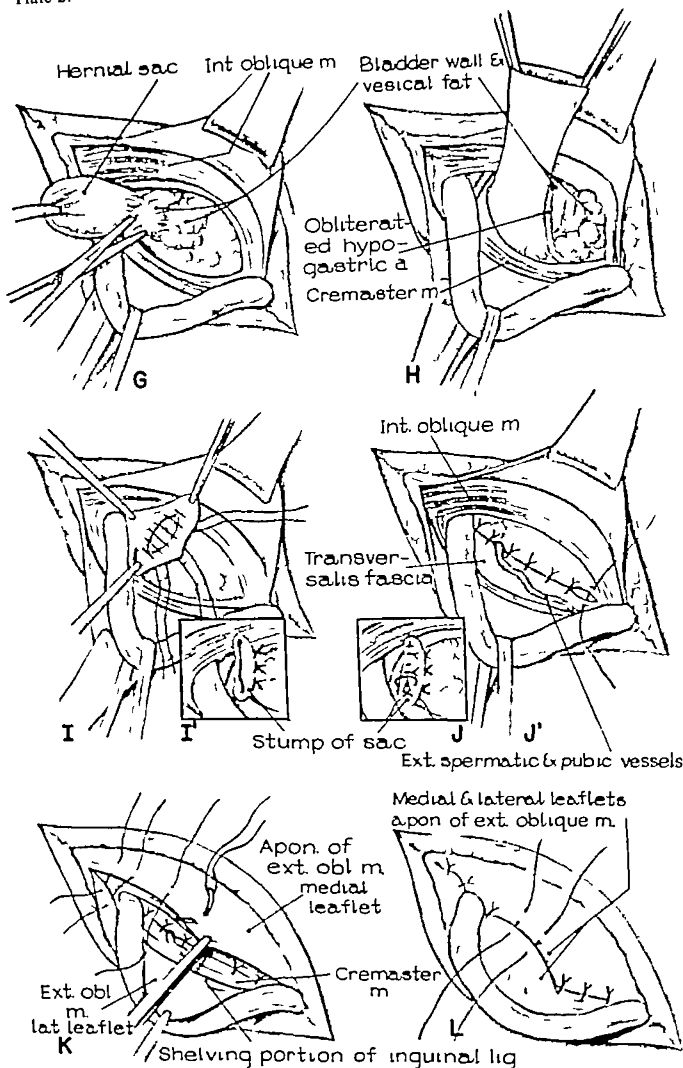
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Plate 27



Hernial sac
Int oblique m
Bladder wall & vesical fat
Obliterated hypogastric a
Cremaster m
G
H
Int. oblique m
Transversalis fascia
I
I'
Stump of sac
J
J'
Ext. spermatic & pubic vessels
Medial & lateral leaflets apon of ext. oblique m.
Apon. of ext. obl m. medial leaflet
Cremaster m
Ext. obl m. lat leaflet
K
L
Shelving portion of inguinal lig

MODIFIED ANSON-McVAY (COOPER LIGAMENT) HERNIORRHAPHY

These illustrations depict the technic in the performance of a modified Anson–McVay type of repair of a direct hernia utilizing Cooper's ligament. It is believed that the anatomic merits of the Anson–McVay type of herniorrhaphy have been overemphasized, and it should not be used as a routine in the repair of direct inguinal hernias. However it is admittedly an anatomic fact that the transversalis fascia inserts into Cooper's ligament. It is also an anatomic fact that the transversalis fascia is normally intimately adherent to the shelving edge of the inguinal ligament. Accordingly in the repair of a direct hernia, if only the lateral leaflet of the transversalis fascia is absent, the medial leaflet of this fascia is sutured to the shelving edge of the inguinal ligament in preference to Cooper's ligament. This can be done without the tension on the suture line which is so frequently observed when this fascia is attached to Cooper's ligament. Furthermore, if the use of the inguinal ligament in preference to Cooper's ligament is wrong anatomically it is logical to assume that there should be a high incidence of postoperative hernias through the femoral canal between Cooper's ligament and the line of suture of the transversalis fascia to the inguinal ligament. However this complication is rarely observed and it is believed more of a theoretic than a practical objection to the use of the inguinal ligament rather than Cooper's ligament. Finally the limitation of the closure proximally by the external iliac vessels and the "dead space" in the trough which is formed when Cooper's ligament is used are further although relatively minor objections to its employment.

A. The resection of the hernial sac is completed, and the large defect overlying Hesselbach's triangle is visible.

B C. Because of the lack of any other tissue with an adequate holding power and the concomitant lax and frayed inguinal ligament, the inguinal floor is reconstructed by enfolding the medial leaflet of the external oblique aponeurosis to Cooper's ligament, without tension, using interrupted sutures of 00 silk. The closure is limited proximally by the external iliac vessels.

D. The lateral leaflet is then imbricated onto the medial leaflet over the trough formed by the suturing of the medial leaflet to Cooper's ligament (C). The cord structures are transplanted beneath the subcutaneous tissue plane, and the subcutaneous tissue and skin layers are closed with interrupted sutures of silk (000).

Discussion—Dr. Moore (cont.)

In reference to the Anson McVay (Cooper ligament) method of hernia repair I should like to state that I have utilized this technic on occasions for many years but have not found it necessary to use it very often. I use it when the inguinal ligament is frayed, weakened, or destroyed as a result of previous operations, or when it has been previously severed as might occur in the course of the reduction and repair of an incarcerated or strangulated femoral hernia. However in the usual case of a direct hernia this method of repair is considered neither necessary nor advisable.

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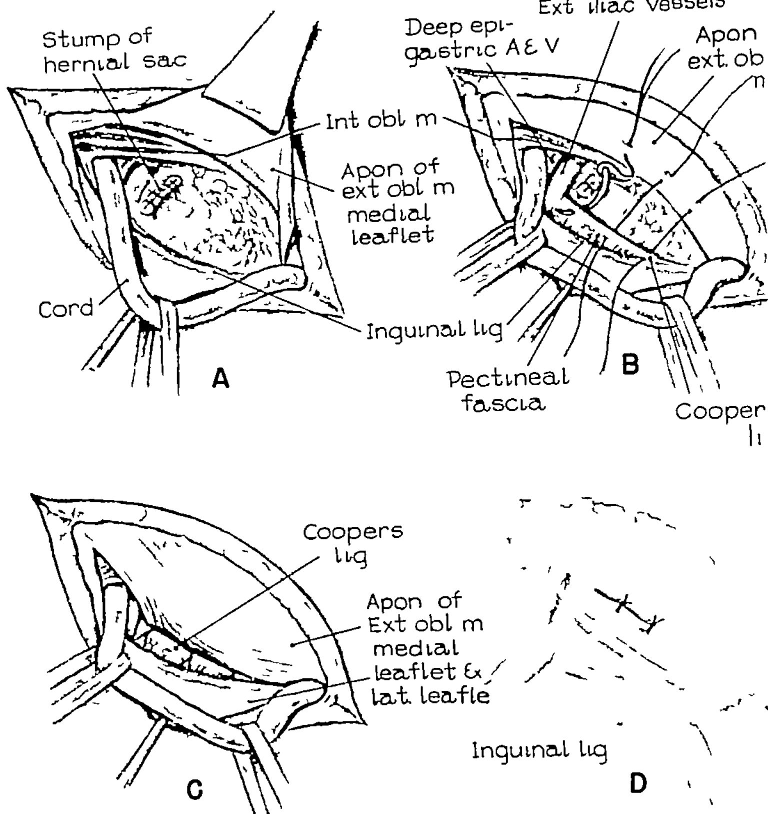
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Plate 28


Stump of
hernial sac
Int obl m
Apon of
ext obl m
medial
leaflet
Cord
Inguinal lig
A
Ext iliac vessels
Deep epi-
gastric A & V
Apon
ext. ob
m
Pectineal
fascia
B
Cooper
li
Coopers
lig
Apon of
Ext obl m
medial
leaflet &
lat. leafle
C
Inguinal lig
D

HERNIORRHAPHY—SLIDING HERNIA

The technic illustrated is based upon the method of repair suggested by Carrington Williams. The simplicity of this method, the technical ease with which reduction of the hernia is accomplished, and the fact that this repair is based upon a clear understanding of the anatomic pathologic changes that occur in a sliding hernia are the main factors which make it an ideal type of operation. It may be employed in the treatment of all varieties of sliding inguinal hernias and is used routinely as the operation of choice.

A. The hernia protrusion is exposed, and the line of incision in the anterior wall of the sac is depicted.

B. The anterior wall of the sac is opened to demonstrate the formation of the posterior wall of the sac by the sigmoid colon. This finding conforms to the definition of a sliding hernia, namely an irreducible hernia in which a portion of the wall of the sac is formed by the protruding viscus.

C. The proximal and distal limits of the incision in the anterior wall of the sac are indicated by the letters *a* and *b* respectively The internal oblique muscle is more widely exposed, and the line of incision into the peritoneal cavity immediately above the iliohypogastric nerve is shown in dotted outline.

D The incision is deepened through the internal oblique and transversus abdominis muscles to expose the line of incision in the anterior parietal peritoneum.

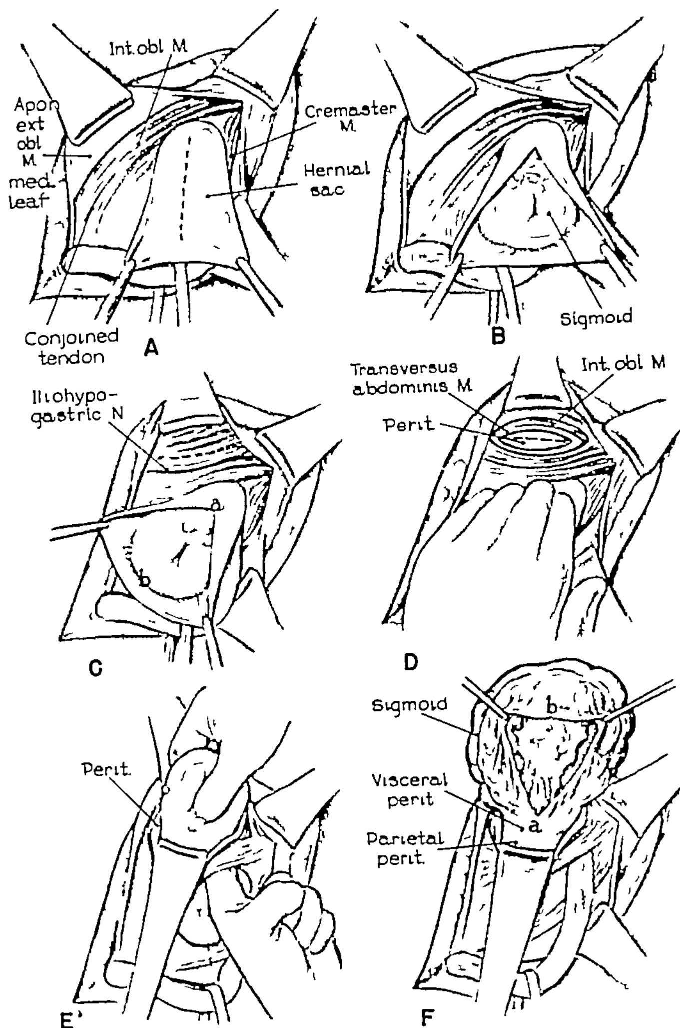
E. The peritoneal cavity is entered, and, by a combination of traction from above and digital manipulation from below the sliding component of the sigmoid colon is reduced into the peritoneal cavity

F The reduction of the sliding hernia is completed, and the sigmoid colon is delivered out of the peritoneal cavity The opening in the anterior wall of the hernial sac is now seen as an actual slit in the mesosigmoid with the letters *a* and *b* in a reversed relation when compared to Figure C.

DISCUSSION—DRS ROLAND L. MAIER AND BRADLEY COLEY A sliding inguinal hernia is one in which part of the colon—sigmoid on the left and cecum on the right—descends into the sac extraperitoneally When this condition occurs, the bowel forms one wall of the sac and makes the desirable high ligation of this sac very difficult or impossible Sliding hernias are not uncommon and must be suspected in all obese individuals with large scrotal hernias The chief danger in the repair lies in not recognizing the situation with resultant perforation of the bowel or impairment of its blood supply The recurrence rate in this type of hernia is much higher than in the ordinary indirect hernia, chiefly because these patients are usually obese and because of the difficulties encountered in obtaining a high sac ligation.

For many years the so-called *Hotchkiss* type of repair has given quite satisfactory results In this procedure, the usual inguinal incision is made, and, after splitting the external oblique aponeurosis, the indirect sac is freed from the cord structures. The sac is then opened on its anterior surface and the diagnosis of a sliding hernia is verified. This opening in the sac is continued up to the internal ring, and the anterior wall of the sac is then excised, leaving a narrow cuff of about one half inch along the edge of the bowel. This remnant of sac is then sutured behind the bowel with interrupted sutures—thus in effect creating a new mesentery The peritoneum is then closed at the internal ring and the bowel is reduced into the

Plate 29



Int. obl M
Apon ext obl M
med. leaf
Cremaster M.
Hernial sac
Conjoined tendon
A
Sigmoid
B
Ilio hypo-gastric N
a
b
C
Transversus abdominis M
Int. obl M
Perit
D
Perit.
E'
Sigmoid
b
Visceral perit
a
Parietal perit.
F

G. The redundant portion of the mesosigmoid is removed, and the free margins remaining are approximated with a continuous suture of fine silk (0000) When the sigmoid colon is reduced into the peritoneal cavity fixation to the parietal peritoneum is not necessary

H. The closure of the opening in the anterior parietal peritoneum is completed, and the overlying muscle layers are approximated, using interrupted sutures of silk (000). The V shaped defect in the transversalis fascia and the relation of the external spermatic and pubic vessels to the deep epigastric vessels are depicted.

I. The closure of the transversalis fascia about the external spermatic and pubic vessels is completed using interrupted sutures of silk (000).

J The medial leaflet of the external oblique aponeurosis is enfolded and approximated with interrupted sutures of 000 silk to the shelving edge of the inguinal ligament. The avoidance of tension on the suture line cannot be overemphasized.

K. The lateral leaflet of the external oblique aponeurosis is imbricated over the medial leaflet using interrupted sutures of fine (0000) silk.

L. Following the insertion of several (three) interrupted sutures in the superficial fascia the skin is closed with interrupted silk (000) sutures.

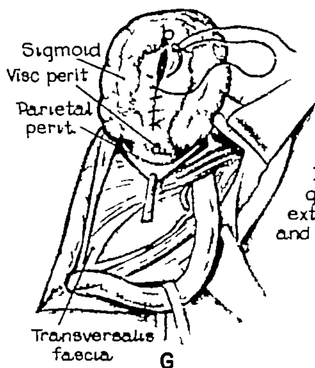
Discussion—Drs Maier and Colley (cont)

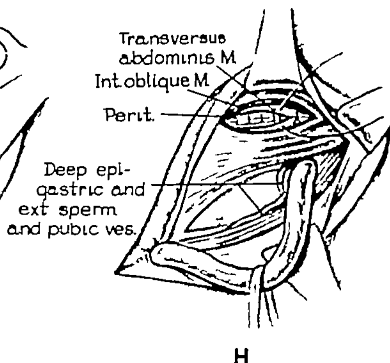
abdominal cavity We are now faced with the problem of closing the large internal ring. In most cases this can be accomplished by suturing the conjoined tendon to Cooper's and Poupart s ligaments as in the usual type of repair and further reinforcing the weak abdominal wall in this area by suturing the external oblique aponeurosis behind the cord On many occasions, in some of the more severe cases, we have found it very helpful to transect the cord or perform an orchiectomy and then completely close the internal ring. In those cases where one deems it advisable to perform a cord transection or orchiectomy it is essential to have the patient s permission before operation to avoid any legal complications. Transection of the cord at the internal ring, if carefully performed without disturbing the testis in the scrotum, in most cases will not lead to sloughing of that organ. It is to be remembered that most of these sliding hernias can be repaired without resorting to cord transection or orchiectomy

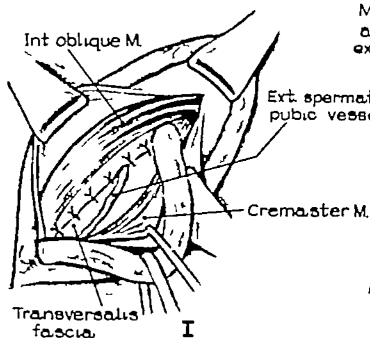
Another very satisfactory method for the repair of difficult sliding hernias has been advocated by Carrington Williams This technic is depicted in the preceding illustrations. It is our feeling, however that while this procedure is ideal for the repair of complicated sliding hernias, it is not indicated in every case.

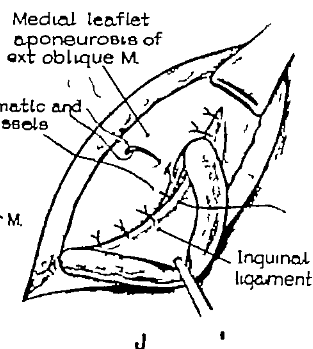
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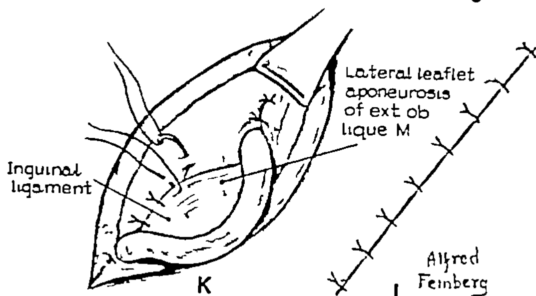
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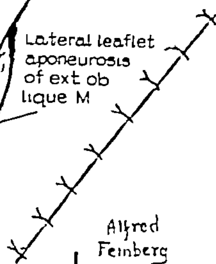

Sigmoid
Visc perit
Parietal perit.
Transversalis fascia
G


Transversus abdominis M
Int. oblique M
Perit.
Deep epigastric and ext sperm and pubic ves.
H


Int oblique M
Ext. spermatic and pubic vessels
Cremaster M.
Transversalis fascia
I


Medial leaflet aponeurosis of ext oblique M
Inguinal ligament
J


Lateral leaflet aponeurosis of ext ob lique M
Inguinal ligament
K


L
Alfred Feinberg

FEMORAL HERNIORRHAPHY—FEMORAL APPROACH

A. The inguinal (*a*) and femoral (*b*) approaches to the repair of a femoral hernia are indicated by the dotted and solid lines, respectively In general the femoral approach is the easier and has proved most satisfactory However if at operation partial resection of the herniated segment of small bowel is indicated, one may encounter difficulty in its accomplishment if this approach is used. Accordingly under such circumstances, the inguinal or an abdominal approach is immediately substituted.

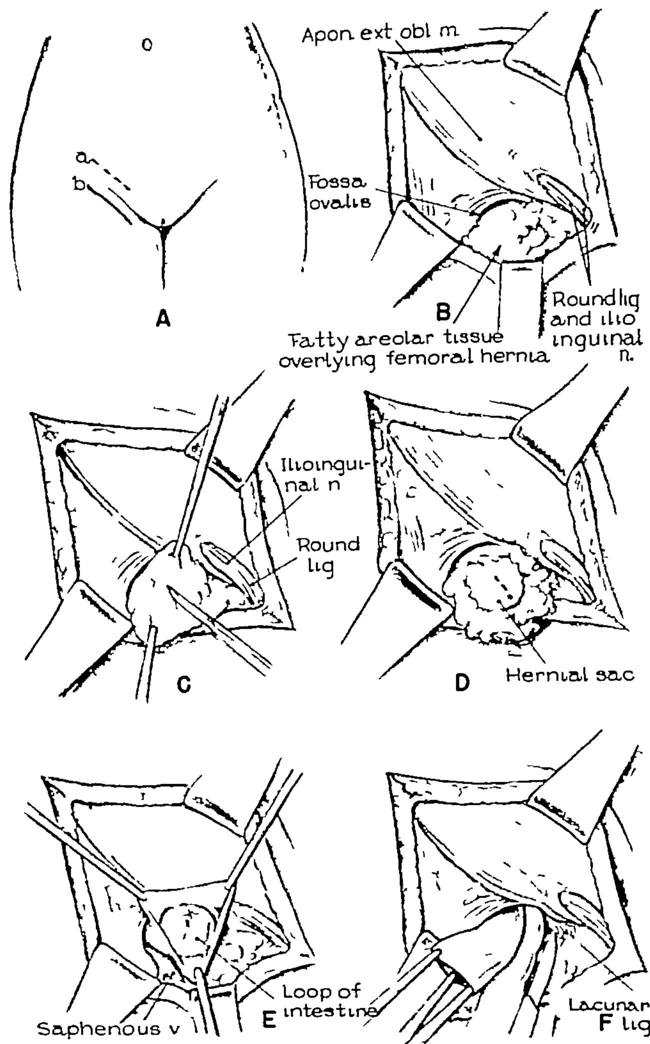
B. An abnormally large operative field is exposed for the purpose of illustrating the anatomic structures of the femoral and inguinal regions.

C, D The properitoneal fat overlying the fossa ovalis is tented with forceps and incised to expose the summit of the hernial sac (D) The line of incision in the sac is indicated by the dotted line.

E. The sac is opened and the incarcerated bu viable segment of small bowel is visible The relation of the saphenous vein to th neck of the sac may be seen.

F The sac, with its imprisoned small bowel is retracted laterally and the tip of the left index finger of the surgeon is gently inserted between the neck of the sac and the rigid concave margin of the lacunar (Gimbernat s) ligament. Using a No 15 scalpe blade on a long handle, the sharp concave margin of the lacunar ligament is incised until the constriction of the neck of the sac is released. In doing this one should proceed with caution because of the possible presence of an aberrant obturator artery the so-called artery of death, in relation to the superior aspect of the lacunar ligament. The release of the constriction about the neck of the hernial sac in this manner is preferred to the severance of the inguinal ligament. This ligament is severed only as a last resort.

Plate 31

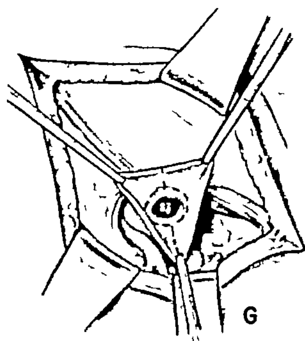

a
b
A
Apon ext obl m
Fossa ovalis
Round lig and ilio inguinal n.
B
Fatty areolar tissue overlying femoral hernia
Ilioinguinal n
Round lig
C
D
Hernial sac
Loop of intestine
Saphenous v
E
Lacunar lig
F

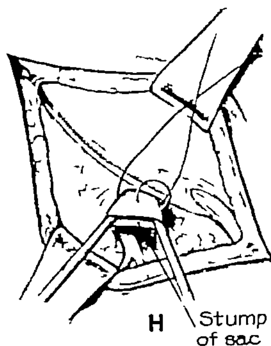
G H The herniated loop of small bowel is re posited into the peritoneal cavity and the extent of the resection of the redundant portion of the hernial sac is indicated by the dotted lines. The neck of the sac is oc cluded with a suture ligature of 00 silk (H)

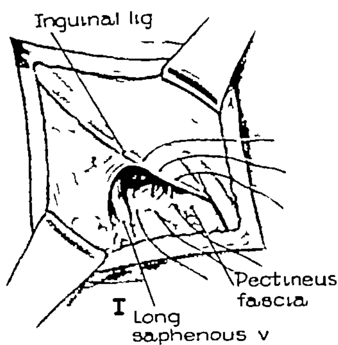
I, J The ligated stump of the sac is retracted spontaneously beneath the inguinal liga ment, and the femoral canal is closed with interrupted sutures of silk (00) which ap- proximate the inguinal ligament to the pec tineus fascia (Bassini), as illustrated in I or by suturing the inguinal ligament to Cooper s ligament (J).

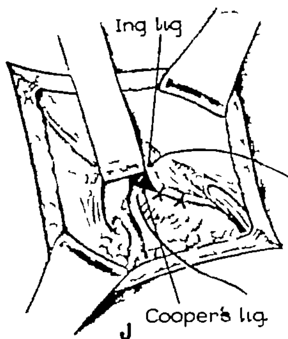
K. The operative field upon completion of the closure of the femoral canal by the suture of the inguinal ligament to Cooper s liga ment is shown. The entrance of the saphe nous vein into the fossa ovalis en route to its junction with the femoral vein is also shown

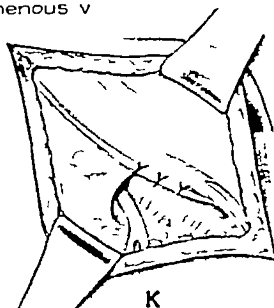
Plate 32


G


H
Stump
of sac


Inguinal lig
Pectineus
fascia
I
Long
saphenous v


Ing lig
Cooper's lig
J

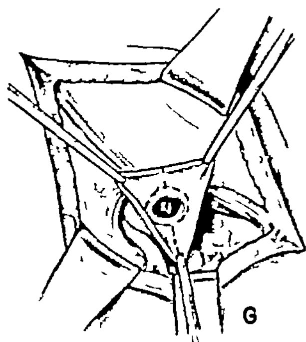

K

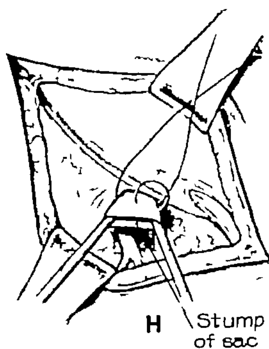
G H The herniated loop of small bowel is reposited into the peritoneal cavity and the extent of the resection of the redundant portion of the hernial sac is indicated by the dotted lines. The neck of the sac is occluded with a suture ligature of 00 silk (H).

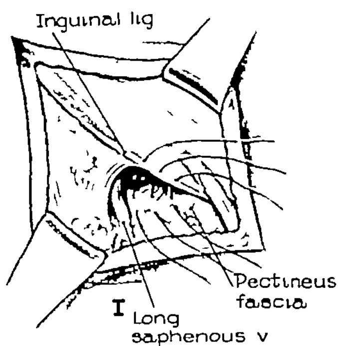
I J The ligated stump of the sac is retracted spontaneously beneath the inguinal ligament, and the femoral canal is closed with interrupted sutures of silk (00) which approximate the inguinal ligament to the pectineus fascia (Bassini), as illustrated in I or by suturing the inguinal ligament to Cooper's ligament (J).

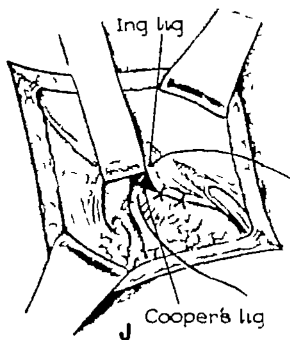
K. The operative field upon completion of the closure of the femoral canal by the suture of the inguinal ligament to Cooper's ligament is shown. The entrance of the saphenous vein into the fossa ovalis en route to its junction with the femoral vein is also shown

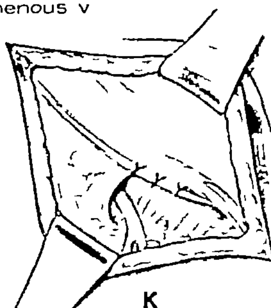
Plate 32


G


H
Stump
of sac


Inguinal lig
Pectineus
fascia
I
Long
saphenous v


Ing lig
Cooper's lig
J


K

FEMORAL HERNIORRHAPHY—INGUINAL APPROACH

This approach, although *more complicated technically than the femoral approach, is in general* more satisfactory It is to be preferred to the femoral approach if there is any indication whatsoever that resection of the herniated segment of small bowel may be required Furthermore, this approach permits a more complete excision of the hernia sac and theoretically lessens the incidence of recurrence of the hernia.

A. A small incision is first made in the proximal portion of the aponeurosis of the external oblique and then extended downward through the external ring by scissor dissection. The extension of the incision is indicated by the dotted line.

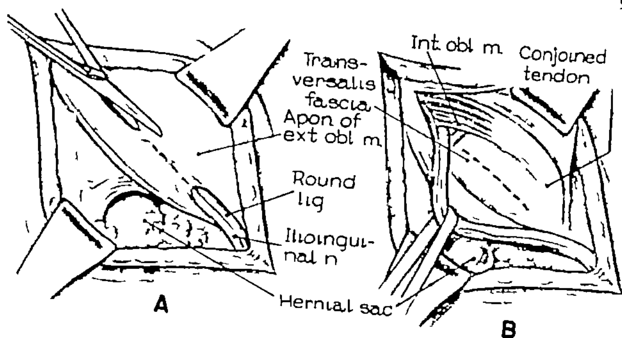
B. The incision is deepened through the underlying cremaster "veil," and the mobilized cord structures, encircled with a cotton tape, are retracted laterally to demonstrate the line of incision in the transversalis fascia.

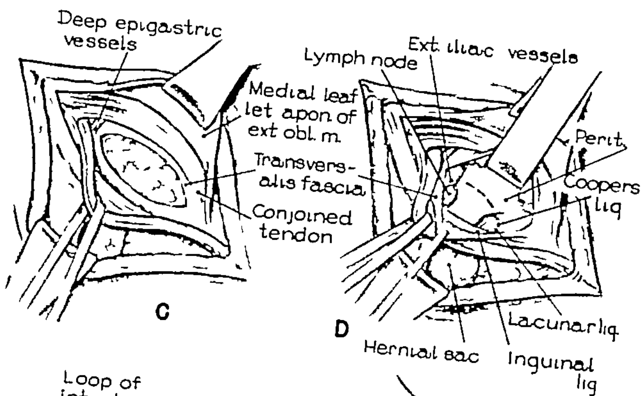
C D The incision is made in the transversalis fascia (C), and the underlying layer of properitoneal fat is retracted to demonstrate the peritoneum and the neck of the hernial sac in relation to the surrounding structures (D) The incision in the peritoneum at the base of the sac is shown by the dotted line

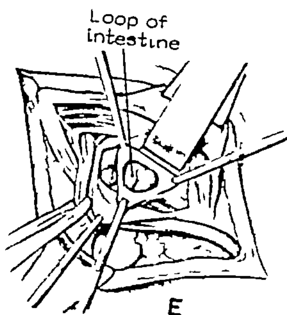
E. The peritoneal cavity is entered, and the afferent and efferent loops of the herniated segment of the small bowel are visible.

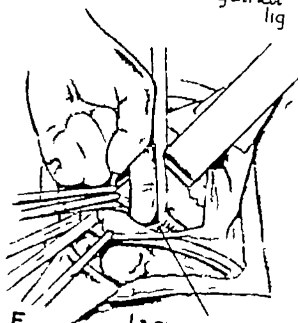
F The clamps on the cut edges of the peritoneum are retracted laterally and the tip of the index finger is gently inserted between the peritoneal wall forming the neck of the sac and the lacunar ligament (Gimbernat's ligament). Similarly as in the approach from below the rigid concave margin of the lacunar (Gimbernat's) ligament is incised and the constriction of the neck of the sac is released. When performed from above the danger of severing an aberrant obturator artery is lessened because of better visibility

Plate 33


Int obl m
Conjoined tendon
Transversalis fascia
Apon of ext obl m
Round lig
Ilioinguinal n
Hernial sac
A
B


Deep epigastric vessels
Lymph node
Ext iliac vessels
Medial leaflet apon of ext obl m
Transversalis fascia
Conjoined tendon
Perit
Coopers lig
Lacunar lig
Hernial sac
Inguinal lig
C
D


Loop of intestine
E



G Following the release of the constriction about the neck of the sac the loop of intestine is withdrawn from the sac through the femoral canal. The dilatation of the released loop of intestine and the ischemic lines of constriction of both the afferent and efferent loops proximally are visible.

H I. A clamp is inserted from the peritoneal cavity into the sac, and, in conjunction with digital manipulation from below (H), the sac is inverted on itself (I) The line of the peritoneal incision for completion of the excision of the sac is shown by the dotted line The femoral canal and the characteristic lymph node adjacent to the external iliac vessels are also demonstrable

J Upon completion of the excision of the hernial sac, the cut margins of the anterior parietal peritoneum are approximated transversely with interrupted mattress sutures of silk.

K L. These insets show the obliteration of the femoral canal by the approximation of Cooper's ligament to the inguinal ligament with interrupted sutures of 00 silk.

M. The incision in the transversalis fascia is closed with interrupted sutures of silk (000) The repair of the hernia is then completed as previously illustrated by enfolding the medial leaflet of the external oblique aponeurosis to the shelving edge of the inguinal ligament and imbricating the lateral leaflet over the medial leaflet The subcutaneous and skin layers are approximated over the transplanted cord structures.

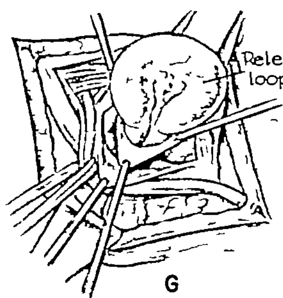
DISCUSSION—DR. S. W MOORE. In the repair of a femoral hernia, no one approach should be used to the exclusion of all others. This is particularly applicable to the repair of large recurrent femoral hernias, the correct treatment of which will at times tax even the most experienced surgeon. In general, however I may say that the repair of femoral hernia is usually easy from a purely technical standpoint

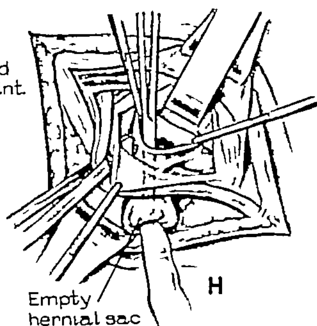
In reference to the particular type of approach to be employed, I prefer an abdominal approach in those instances of strangulated hernia in which a resection of a gangrenous segment of intestine is required. However under such circumstances, I have undertaken the resection of bowel segments utilizing the inguinal approach Regardless of the method of approach, incision of the lacunar ligament is very helpful in reducing an incarcerated or strangulated femoral hernia. In performing this particular maneuver one must be ever on the alert for the possible presence of an aberrant course of the obturator artery The inguinal or Poupart's ligament should be severed only after all other methods for the reduction of a femoral hernia have failed.

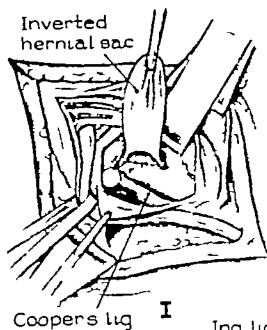
The repair of a femoral hernia from below is stated to be associated with a high rate of recurrence. A recurrence is more apt to occur when the pectineus fascia is used. Personally I prefer to suture Cooper's ligament to the inguinal ligament for the closure of the femoral ring. In 1943 I published a report on the repair of a femoral hernia from below suturing Cooper's ligament to the inguinal ligament, and I have not observed a case in which this was not possible to perform. I think it is superior to the performance of the same type of repair from above as it avoids the necessity for the additional repair of the inguinal canal which is required when the inguinal approach is employed.

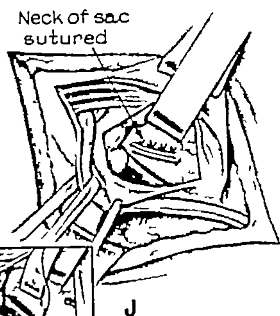
The combined inguinal and femoral approach for the repair of a femoral hernia is used in the surgical management of difficult or recurrent hernias where I am unable to reduce the hernia from below Femoral hernias are always repaired from below except in those instances in which the use of the inguinal approach is required in order to accomplish the reduction of the hernia.

Plate 34


Released
loop of int.
G

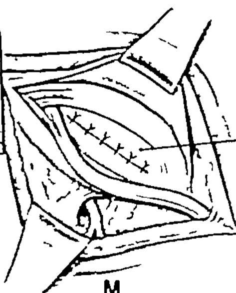

Empty
hernial sac
H


Inverted
hernial sac
Coopers lig
I


Neck of sac
sutured
J


Ing lig
K
Coopers lig


Coopers lig
L Ing lig


Transversalis
fascia
M

FEMORAL HERNIORRHAPHY—COMBINED INGUINAL AND FEMORAL APPROACH

The combined approach in the repair of an easily reducible femoral hernia is demonstrated to show mainly the related anatomy of the inguinal and femoral regions.

A. A wide exposure of the operative field is shown for anatomic relations, and the incision of the properitoneal fat overlying the femoral hernial protrusion is depicted by the dotted line.

B. The hernia is exposed in the femoral region, and the exposure from above the inguinal ligament is commenced by severance of the aponeurosis of the external oblique in the direction of its fibers to open the external ring. This action is indicated by the dotted line

C. The inguinal incision is deepened through the transversalis fascia, and the properitoneal fat and the peritoneum and the neck of the sac of the femoral hernia are exposed. A cotton tape is inserted through the femoral canal to encircle the inguinal ligament and the cord structures. The T shaped incision for resection of the redundant portion of the empty hernial sac is indicated.

D E. The neck of the sac of the femoral hernia is occluded with a transfixion suture of 00 silk (D) and reduced through the femoral canal into the inguinal region (E). The operation then continues as illustrated in the repair of a femoral hernia utilizing the inguinal approach.

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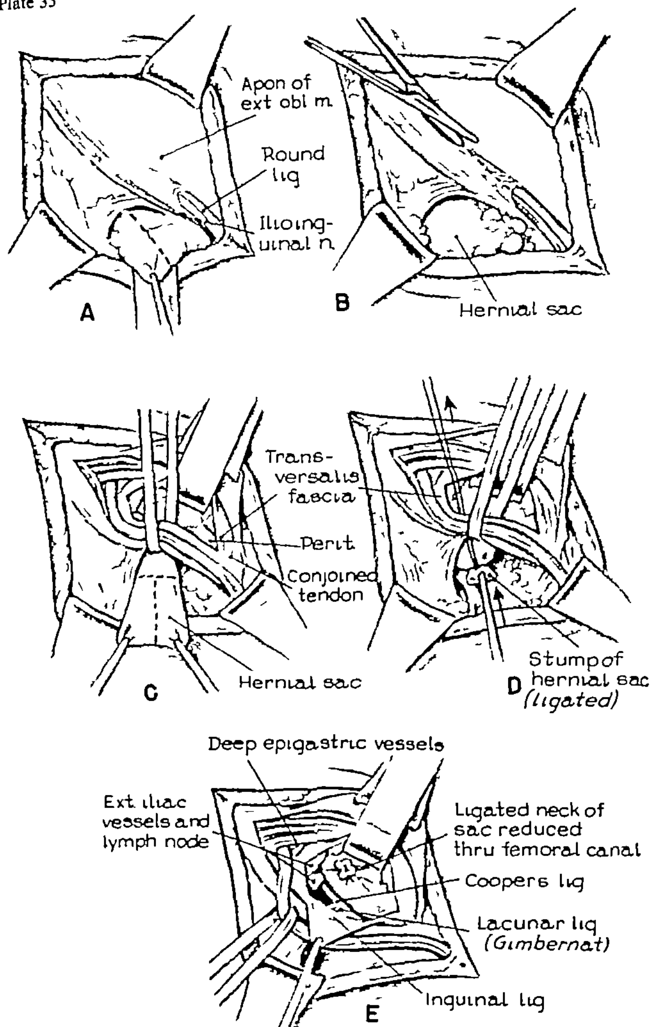
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Plate 35


Apon of
ext obl m.
Round
lig
Ilioing-
uinal n.
A
B
Hernial sac
Trans-
versalis
fascia
Perit.
Conjoined
tendon
Hernial sac
C
Stump of
hernial sac
(ligated)
D
Deep epigastric vessels
Ext. iliac
vessels and
lymph node
Ligated neck of
sac reduced
thru femoral canal
Coopers lig
Lacunar lig
(Gimbernat)
Inguinal lig
E

HERNIORRHAPHY—INCISIONAL HERNIA

A. The incisional scar overlying the hernial protrusion is excised in an elliptical manner as indicated in the dotted outline.

B. The elliptical excision of the operative scar is completed, and the thinned out fibrous tissue (false hernial sac) which encases the hernial contents is shown.

C. Sterile towels are fixed to the skin edges with towel clips through which upward and outward traction is maintained as scalpel dissection is commenced beneath the subcutaneous fatty tissue plane. This dissection is extended widely on either side to the margins of the lateral abdominal wall. This is considered an essential basic step in the operative repair of incisional hernias. Following the completion of the dissection on one side several warm moist gauze pads are placed beneath the mobilized flap and a similar dissection is performed on the opposite side.

D. The mobilization of the flaps is completed, and the relation of the hernial protrusion to the surrounding fascia and muscles of the anterolateral abdominal wall is depicted.

E. An incision is made parallel to the lateral margin of the hernia through the line of junction of the true and false fascia, and a portion of the underlying rectus muscle is exposed. Clamps are applied to the cut edge of the true fascia, and with lateral traction maintained, the incision is continued distally to join the lower portion of a similar incision completed on the opposite side.

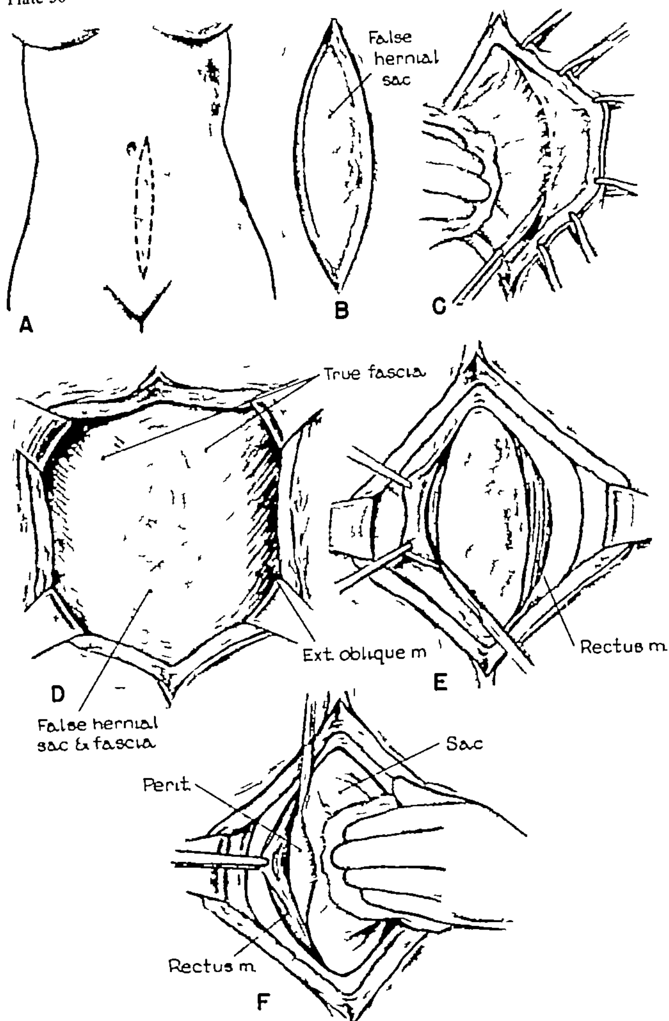
F. Scalpel dissection is continued and the medial border of the rectus muscle is separated from the side of the false hernial sac exposing the underlying layer of transversalis fascia and peritoneum.

DISCUSSION—DR. DANIEL F. CASTEN. The occurrence of incisional hernias is dependent upon many factors: location of incision, type of suture material, infection, postoperative stress upon the incision, and poor technic of abdominal wall closure. Some of these factors are definitely amenable to correction, and with properly placed incisions, careful attention to every detail of closure, and avoidance of postoperative distention, the incidence of incomplete wound dehiscense should be materially decreased. The work of Dunphy and others has increased our knowledge considerably in the field of hormonal and metabolic factors concerned in the healing of incised wounds, and clinical application of these data should prove rewarding.

These illustrations define the ideal repair for abdominal incisional hernias. The layers of the abdominal wall are cleanly dissected and delineated. They appear to be of satisfactory strength and texture, and the defect is small enough to permit a layer closure with an anterior rectus sheath overlap. This is the goal for our surgical repair: reapproximation of anatomic layers in normal sequence and without tension. The use of nonabsorbable sutures, as illustrated, is essential for the maintenance of the repair until fibroplasia is complete.

Unfortunately, however, one is frequently unable to approach this ideal. The layers of the abdominal wall at the site of herniation may be scarred and fused. *The false hernial sac, as demonstrated (Plate* 36 B) represents fusion of remnants of fascial elements with peritoneum. The tissues adjacent to the sac may also be involved in this process of fusion and scarification and, therefore, are frequently unsatisfactory for use as a buttress. Furthermore, the sac may be so adherent to the underlying viscera that separation is virtually impossible. Finally, the defect may be so large or so located that approximation of the edges cannot be accomplished. The rectus muscles in these larger hernias become attenuated and are useless for purposes of repair; the fascial layers, having been replaced by scar tissue, may appear strong, but, because of loss of elasticity, are unable to resist the forces of intraabdominal pressure.

Plate 36



False hernial sac
A
B
C
True fascia
D
False hernial sac & fascia
Ext. oblique m
E
Rectus m
Sac
Perit.
Rectus m
F

G The mobilized musculofascial layers are retracted, and using a scalpel the dissection of the false hernial sac is completed.

H An elliptical excision of the false hernial sac (dotted lines) along the line of junction with the normal fascia peritoneal layer is commenced.

I. The excision of the false hernial sac is completed, and the closure of the fascia peritoneal layer using interrupted mattress sutures of silk (00), is begun.

J The fascia-peritoneal closure is completed, and the muscle layer is loosely approximated with simple interrupted sutures of silk (00) In many instances the closure of this layer is omitted because of either the

atrophy of the muscles or the excessive tension on the suture line

K. An imbrication type closure of the anterior fascial layer is performed using both horizontal mattress and simple interrupted sutures of 00 silk. If undue tension on the suture line is present, linear relaxing incisions in the fascia laterally on either side are made

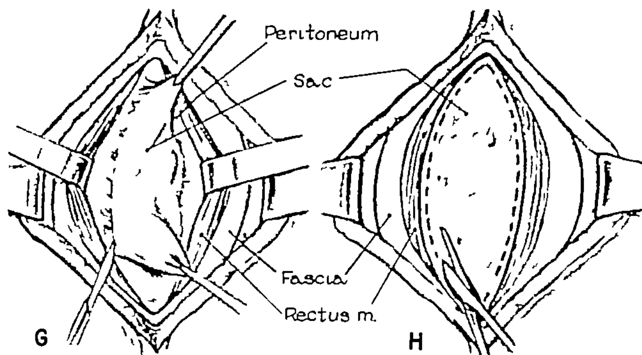
L. The closure of the skin incision with interrupted sutures of silk completes the operation. Because of the extensive undermining of the flaps of skin and subcutaneous fatty tissue, drains are frequently used and have their exit through stab wounds lateral to and on either side of the skin closure.

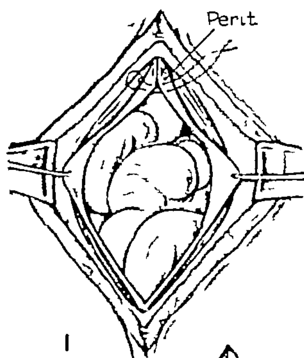
Discussion—Dr. Casten (cont.)

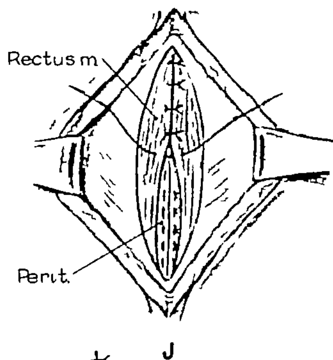
Many alternative procedures have been recommended to meet these situations. The treatment of the sac, for example varies considerably I believe, with Dr Madden, that excision is desirable if possible but it has been my practice to leave portions of the sac behind if the visceral adhesions render separation hazardous. Methods of inversion of the sac by serial rows of sutures without opening into the peritoneal cavity are dangerous since one does not expose the underlying viscera. Furthermore, this method may predispose to postoperative intestinal obstruction

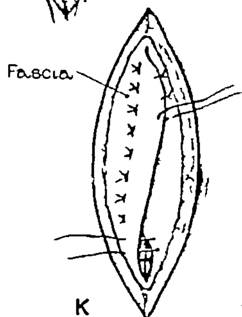
If the fascial and peritoneal layers are fused, individual closure as depicted in Plate 37 (I J and K), is impossible In these individuals an overlap procedure of the fused layers in a vertical or transverse axis similar in principle to the Mayo technic for closure of umbilical hernias is adequate and satisfactory Relaxing fascial incisions may be employed when necessary and many seemingly impossible repairs can be effected In small defects I prefer a transverse closure since the lines of force exerted upon the abdominal wall during stress tend to approximate rather than separate the edges. Large defects, of necessity require a vertical closure. Herniations in the subcostal areas or in the upper midline offer certain difficulties. In the former the unyielding upper costal edge presents a barrier to closure, and in the latter the relatively fixed fascial layers present a challenge to adequate mobilization and sufficient relaxation for secure repair In these hernias and in all large hernias through the abdominal wall my preference is the use of tantalum mesh for the repair as advocated by Koontz. The peritoneal and fascial layers are defined and approximated as carefully as possible without tension, and the residual defect is covered with a sheet of tantalum mesh Considerable experience with this method has demonstrated its value and prolonged follow-up observations have confirmed this impression. A firm, unyielding proliferation of fascia occurs through the interstices of the mesh, and even though this frequently becomes fragmented the closure remains firm The use of tantalum or surgical steel mesh is preferred to fascial flap or graft procedures.

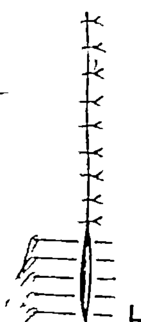
As a final note, a recent experience with preoperative pneumoperitoneum, as advocated by Russo and Mazzini in the preparation for operation of a patient with a huge incisional hernia which had lost its "right of domicile" and some past unfortunate experiences in the forceful reduction of these hernias has suggested the more frequent employment of this method.


Peritoneum
Sac
Fascia
Rectus m.
G
H


Perit.
I


Rectus m
Perit.
J


Fascia
K


L

HERNIORRHAPHY—UMBILICAL HERNIA

A. The outline of the curvilinear supraumbilical incision that is used in children with preservation of the umbilicus is shown. Similarly an infraumbilical incision may be employed, depending upon the site of the hernial protrusion in relation to the umbilicus.

B. The elliptical incision that is employed in the adult with removal of the umbilicus is demonstrated.

C. An opening is made into the peritoneal cavity and the contents of the sac are reduced. The index and middle fingers of the left hand of the surgeon are inserted into the lumen of the sac as protective guides and the redundant sac tissue is excised.

D Inset to show the closure of the peritoneum as a separate layer using interrupted mattress sutures of 000 silk. In general, in this type of hernia, an attempt to approximate the rectus muscle in the midline will cause excessive tension on the suture line, and accordingly should not be done.

E. This demonstrates the more usual type of closure in which the peritoneum and fascia are closed together as a single layer using imbrication sutures of 00 silk

F The lower layer is anchored beneath the upper layer when the sutures previously inserted (E) are tied. The overlapping portion of the upper layer is then sutured to the subjacent lower layer with interrupted sutures of 000 silk. If preferred, the lower layer may be imbricated over the upper layer which is the reverse of the method illustrated.

DISCUSSION—DR. DANIEL F CASTEN The illustrations demonstrate in adequate detail the steps of the classical Mayo technic of repair which has been so successful in the treatment of umbilical hernias. In the usual case with a defect of moderate size, one can find no fault with this method as depicted. Two methods of dealing with the umbilicus are shown. It has been my practice to preserve the umbilicus in most patients. The redundant skin soon contracts satisfactorily and the final cosmetic effect is more pleasing.

The inset (D) demonstrates an alternative method in which the peritoneum is closed independently This is desirable, if possible since layer closure of the abdominal wall is always preferable. However in large hernias of long duration the layers have become fused and the defect in the linea alba must be closed as a single layer

As a rule the contents of the sac may be reduced without difficulty but if a large mass of omentum is present, resection is preferable to replacement in order to avoid a sudden increase in intraabdominal tension In elderly patients, reduction of large umbilical hernias may cause respiratory distress which is poorly tolerated omental resection frequently prevents this complication.

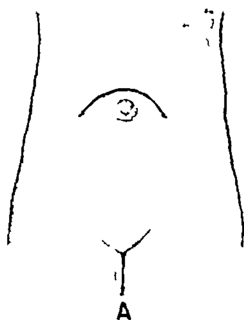
As can be seen from the two final drawings (E, F), the Mayo technic of repair is strongest at the midpoint where the overlap is most effective but becomes progressively less secure at the angles where the overlap is minimal or absent In large hernias this leaves two lateral areas of weakness. This may be remedied partially by making two lateral incisions at the edges of the ring, converting a circular opening into an elliptical one This is not completely satisfactory however since the angles still are only partially overlapped.

To correct this inadequacy Harvey Stone, in 1926 published the details of a different type of repair In this, the preliminary steps are the same as in the Mayo repair and the edges of the ring are delineated. These are then approximated transversely with a series of Halsted mattress sutures. This line of closure is then inverted by a second layer of mattress sutures placed so that the first line of sutures is turned inward, and a buttress of fascia is formed. The second row of sutures starts well lateral to the ends of the first row thus effectively securing a strong angle closure. Occasionally transverse relaxing incisions in the anterior sheath may be necessary These cause no weakness in the abdominal wall as the defects are rapidly filled by fascial ingrowth. I have used the Stone method for many years and know of only one recurrence.

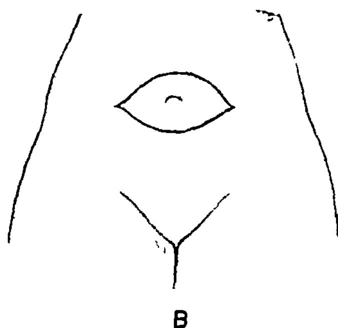
I should like to stress the necessity for adequate exploration of the linea alba in the supraumbilical area at the time of surgery Small midline epigastric hernias may be present, and if found, are readily repaired. If overlooked they may cause persistence of symptoms or simulate a recurrence of the umbilical hernia.

In infants and young children, small umbilical hernias tend to close spontaneously in contrast to inguinal hernias Therefore, I believe that operation should be deferred until it becomes apparent that spontaneous closure will not occur

REFERENCES (see page 636)



A



B

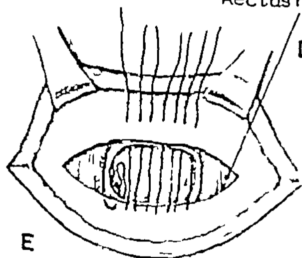
Ant rectus sheath

Perit

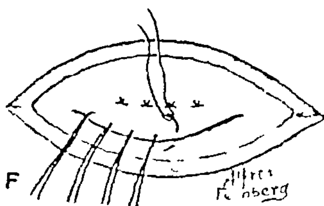
Rectus m

C

D



E



F

EXCISION OF PILONIDAL CYST

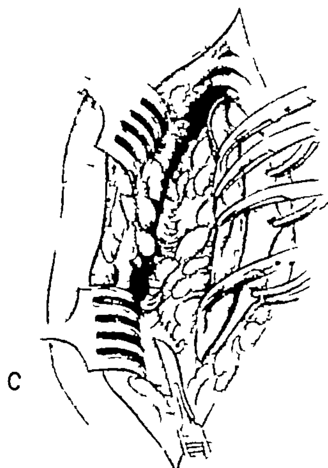
A The patient is placed in the prone and modified "jackknife" position, and the buttocks are separated by strips of adhesive tape which are fixed to the sides of the operation table. The sites of attachment of these strips to the skin of the buttocks is reinforced by short lengths of adhesive tape applied at right angles to the underlying layer forming a T-shaped pattern. The elliptical incision about the orifices of the pilonidal sinus is outlined *The injection of methylene blue into the orifices of the sinuses is neither practiced nor recommended* The technic of excision depicted in the subsequent illustrations is essentially a modification of the method previously described by Dunphy and Matson.

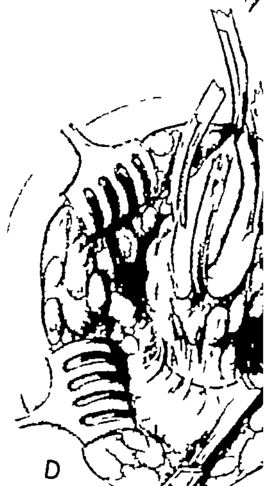
B C. The incision is deepened through the thick subcutaneous fatty tissue layer first on one side and then the other to expose the sacral fascia in the depths of the wound In this dissection it is most important that all of the diseased tissue is excised. Accordingly as the dissection proceeds the lateral walls of the wound are carefully inspected for small islands of grayish gelatinous tissue which resemble tapioca pudding in appearance. If such islands of diseased tissue are seen, the area of excision should be extended laterally as far as necessary to assure their complete removal.

D Traction, with the aid of Kocher clamps, is maintained on the cut margins of the elliptical skin segment to be excised, and the tissue attachments to the sacral fascia are severed as indicated (dotted line) by scalpel dissection.


A


B

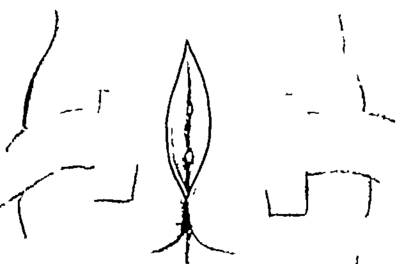

C


D

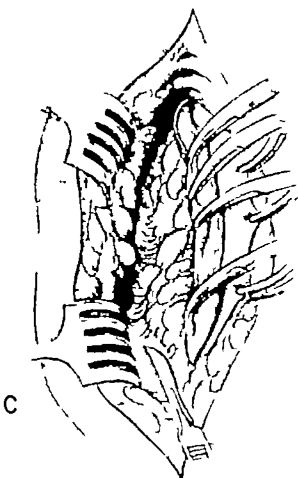
A. The patient is placed in the prone and modified "jackknife" position, and the buttocks are separated by strips of adhesive tape which are fixed to the sides of the operation table The sites of attachment of these strips to the skin of the buttocks is reinforced by short lengths of adhesive tape applied at right angles to the underlying layer forming a T-shaped pattern. The elliptical incision about the orifices of the pilonidal sinus is outlined. *The injection of methylene blue into the orifices of the sinuses is neither practiced nor recommended.* The technic of excision depicted in the subsequent illustrations is essentially a modification of the method previously described by Dunphy and Matson.

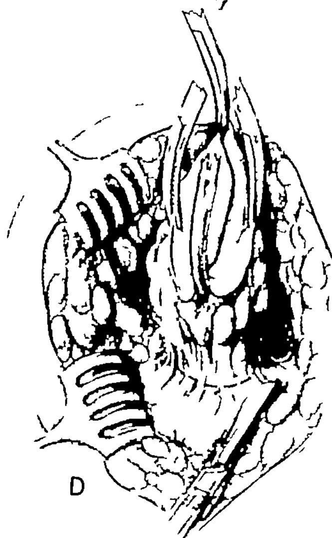
B C. The incision is deepened through the thick subcutaneous fatty tissue layer first on one side and then the other to expose the sacral fascia in the depths of the wound. In this dissection it is most important that all of the diseased tissue is excised. Accordingly as the dissection proceeds, the lateral walls of the wound are carefully inspected for small islands of grayish gelatinous tissue which resemble tapioca pudding in appearance If such islands of diseased tissue are seen, the area of excision should be extended laterally as far as necessary to assure their complete removal.

D Traction, with the aid of Kocher clamps, is maintained on the cut margins of the elliptical skin segment to be excised, and the tissue attachments to the sacral fascia are severed as indicated (dotted line) by scalpel dissection.




B


C


D

E. The severance of the tissues in the depths of the wound from the sacral fascia is continued cephalad, and the excision of the pilonidal cyst is completed (F).

F. After completion of the excision of the cyst, rake retraction is maintained on the wound margin, and the attachment of the fibrofatty tissue layer to the surface of the gluteus maximus muscle is separated by sharp scalpel dissection. During this dissection active bleeding from the cut vessels in the gluteus maximus muscle always occurs and requires the application of clamps for the control of hemorrhage.

G. The dissection of the fibrofatty tissue layer on each side of the wound is completed, and hemostasis within the gluteus maximus muscle is obtained with suture ligatures of silk (000).

H. A series of four interrupted skin retention sutures of silk (No. 1) are inserted, each of which incorporates a "bite" of the sacral fascia.

DISCUSSION—DR. WILLIAM F. MACFEE. Pilonidal cysts and sinuses have been treated by a variety of methods, but most surgeons rely upon wide excision which is intended to encompass the possible ramifications of the sinus tract. The usual procedure begins with an elliptical incision which includes the openings of the sinuses with a narrow zone of surrounding skin. The excision comprises a considerably wider area of subcutaneous fat extending down to the sacrococcygeal fascia in the center and to the gluteal fascia at the margins.

With respect to the actual technic of excision, the injection of methylene blue or other dye into the sinus serves no useful purpose. The dye not only obscures the operative field but may actually be misleading through its failure to reach all parts of the sinus tract and its possible ramifications. After the skin incision has been made, the surgeon proceeds according to the plan of excision he considers best. As the first step, the drawings B, C, and D, Plate 39 show the lateral incisions carried to their full extent. Following this, the tissues in the depth of the wound are severed from the sacral fascia in a cephalad direction (Plate 40, E).

An objection which may be offered to the early completion of the lateral incisions is the fact that the slight ooze of blood from these incisions tends to run down and obscure the field during the dissection of the tissue mass from the sacrum. If, instead, the incisions are carried to the required depth only at the inferior angle of the ellipse and then progressively deepened as the tissues are dissected from the sacral fascia, a much clearer operative field is obtained with less effort.

On the management of the wound created by the excision, opinions differ. Some favor primary closure while others prefer to leave the wound open, or at least partially open, and pack it with gauze. Another method of closure designed to obliterate dead space and reduce raw surface is the suturing of the skin edges to the sacral fascia along, or near, the midline.

Closure of the wound by primary suture is the ideal method, provided primary healing follows. However, virtually all such wounds are contaminated in some degree, and the combination of a small residual dead space with the presence of a few bacteria is sufficient to cause failure. The tissues beneath the skin become separated by a hematoma or an abscess, and the wound then must heal by granulation.

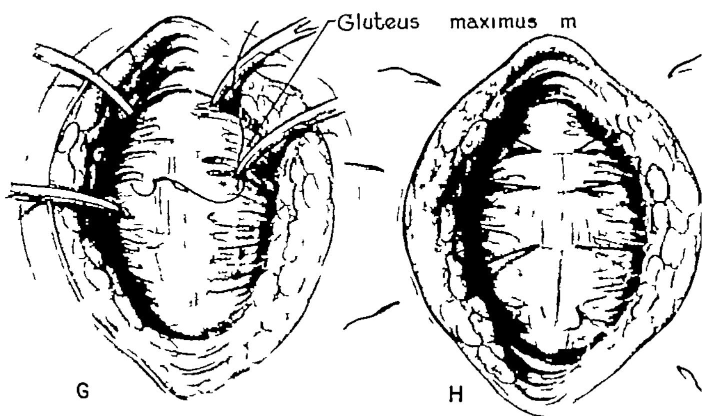
Packing of the open wound is, in effect, an acceptance of a type of healing that is slow but assured, to be sure. Unfortunately, healing is by no means sure. Regardless of frequent changes of packing, the process of granulation tends to proceed more rapidly along the surfaces of the subcutaneous fat than in the depth of the wound, over the sacrum, where granulations apparently form more slowly and grow less luxuriantly. The result is a constant tendency of the wound to close superficially, leaving a deep zone of incomplete healing over the sacral fascia. Low grade infection may persist at this level and become active after healing appears to be complete. It may be regarded as a recurrence of the original condition and the patient subjected to a second excision. The tissue removed at the second operation frequently discloses a sinus tract leading down through scar tissue, but without epithelial lining.

Closure by suture of the skin edges to the sacral fascia obliterates dead space by bringing the relatively vascular walls of the wound down into a position of direct contact with the sacral fascia. An uncovered area of fascia, usually not more than one cm. wide, is left between the skin edges, either to epithelialize naturally or to be grafted. If this type of closure is selected, the residual raw surface must receive the surgical attention normally required by any superficial granulating wound. Whatever the type of operation, a common cause of failure is inadequate treatment of the residual wound.

Sacral fascia

E

F



I Drains (two) are inserted in the upper and lower angles of the wound down to the sacral fascia, and the suture of the fibrofatty tissue layer is commenced. This layer which was previously separated from the surface of the gluteus maximus muscle possesses good holding power and its approximation effects a strong layer of closure in the depths of the wound Immediately prior to this closure, the traction tapes of adhesive separating the buttocks are released to prevent tension on the suture line

J The closure of the deep fibrofatty tissue layer about the drains is completed and the closure of the skin margins of the wound is partially completed, using interrupted sutures of silk (000). If preferred, vertical on end mattress sutures (MacMillan) may be used for the skin closure.

K L. Following completion of the skin closure the drains are incorporated in a gauze dressing over which a gauze roll is applied The retention sutures are then tied firmly over the gauze roll and dressing to effect an obliteration of the underlying dead space The application of two additional layers of gauze and a firm adhesive dressing completes the operation.

Postoperatively a regular diet as tolerated is prescribed and no attempt is made to inhibit bowel motions by the use of various medications. The retention sutures and the drains are removed routinely on the fourth day and the skin sutures on the eighth day postoperatively The day after the skin sutures are removed tub baths are prescribed and continued daily thereafter for a period of five to seven days.

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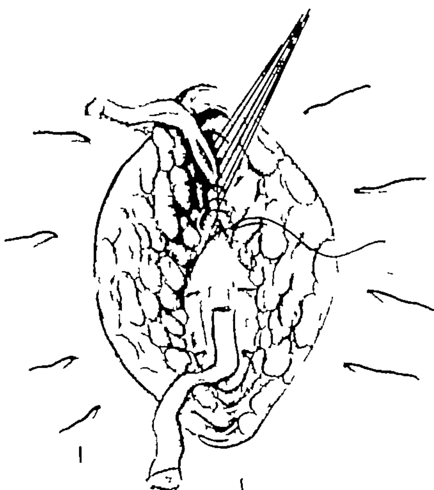
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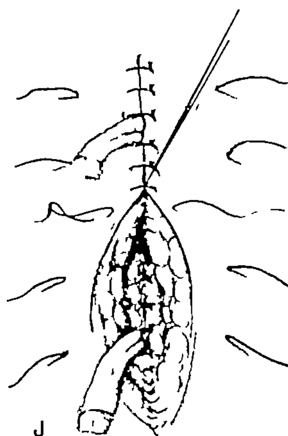
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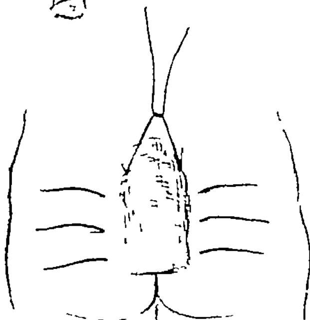
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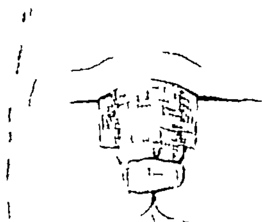
Plate 41







K



L

RADICAL MASTECTOMY

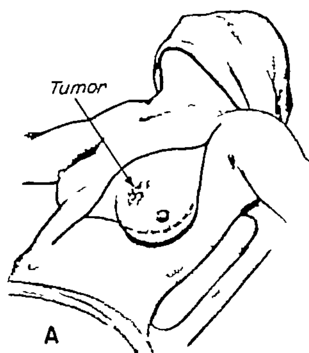
A. The patient is placed in the supine position and the left side of the thorax is elevated on a pillow support. The location of the tumor in the lower medial quadrant of the left breast is visible and the outline of the skin incision is depicted. The incision used, a slight modification of the Willy Meyer (1894) and John B. Deaver (1917) incisions, is one that has proved the most universally applicable. Extension of the incision onto the upper third of the arm is neither necessary nor desirable. Alternate types of incision which are in general use are depicted in Plates 46, 47, and 48.

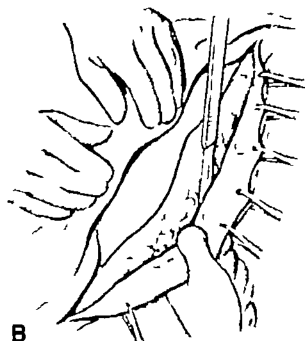
B, C. A sterile moist towel folded once longitudinally is attached to the cut margin of the lateral skin flap with towel clips. Traction is maintained upward on the lateral skin flap and scalpel dissection is continued both laterally and posteriorly until the anterior border of the latissimus dorsi muscle is exposed.

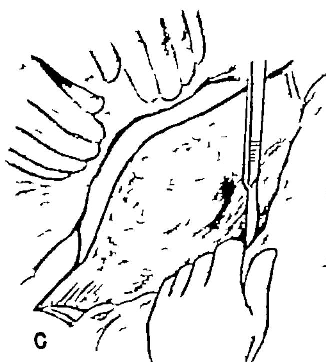
D. In like manner a folded sterile moist towel and towel clips are applied to the cut edge of the medial flap and with traction maintained, the scalpel dissection is continued in the superficial subcutaneous plane until the mobilization of the flap is completed to the right border of the sternum. In the elevation of the skin flaps, a wide dissection in the superficial subcutaneous tissue plane is routinely performed and a thin layer of subcutaneous fat is permitted to remain on the undersurface of either flap.

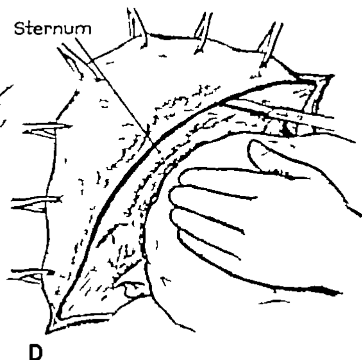
E. Upon completion of the mobilization of the medial and lateral skin flaps, the island of skin overlying the breast tumor and the surrounding breast tissue is covered with a small dry sterile towel, the edges of which are anchored to the skin margins with a series of Kocher clamps.

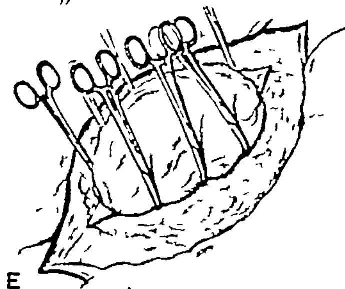
Plate 42











F To facilitate manipulation of the breast by the assistant, the handles of the Kocher clamps are secured together about a crumpled sterile towel with a piece of gauze tape

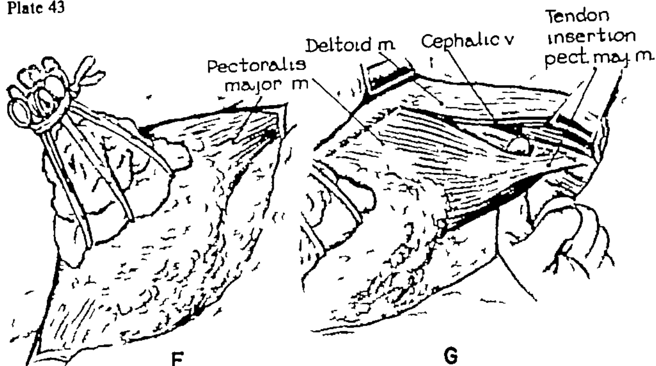
G The cephalic vein, an anatomic landmark for the deltopectoral groove is first identified, and then a cleavage plane between the fibers of the pectoralis major and deltoid muscles is obtained. The tendon of insertion of the pectoralis major is encircled by the left index finger of the surgeon, and the characteristic twisting of its fibers prior to insertion into the humerus along the lateral crest of the bicipital groove is shown This tendon of insertion and the origin of the clavicular portion of the pectoralis major are severed as indicated by the dotted lines The clavicular portion of the pectoralis major is resected routinely in the performance of a radical mastectomy

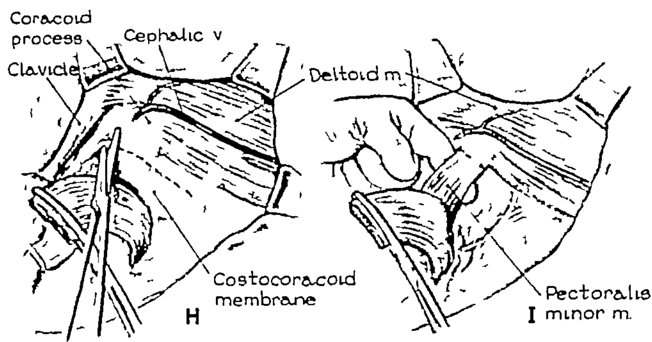
H. The mobilized portion of the pectoralis major muscle is turned downward and medially to expose the line of incision in the costocoracoid membrane (coracoclavicular or clavipectoral fascia) which forms a thin and somewhat transparent covering over the tendon of insertion of the pectoralis minor muscle into the coracoid process of the scapula. The coracoid process is also the site of origin of the coracobrachialis muscle and the short head of the biceps brachii muscle Scissor dissection of the costocoracoid membrane is commenced preliminary to the mobilization of the tendon of insertion of the pectoralis minor muscle

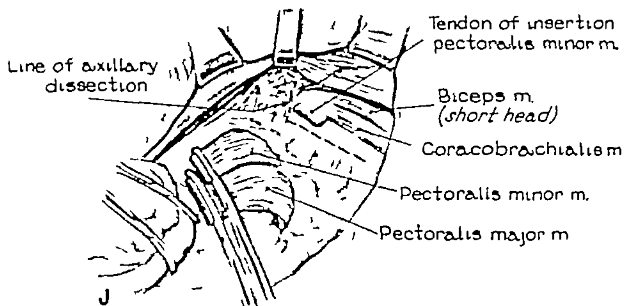
I. The scissor dissection of the costocoracoid membrane is completed, and the tendon of insertion of the pectoralis minor muscle is elevated upon the left index finger preparatory to its severance from the coracoid process as indicated by the dotted line

J The mobilized tendons of insertion of both the pectoralis major and minor muscles are turned downward and the line of the axillary dissection is shown. This dissection commences medially in an area cephalad to the brachial plexus and axillary vessels The outlines of the axillary vein and its tributaries are faintly visible.

Plate 43


Pectoralis major m
Deltoid m
Cephalic v
Tendon insertion pect. maj. m.
F
G


Coracoid process
Clavicle
Cephalic v
Deltoid m
Costocoracoid membrane
H
Pectoralis minor m.
I

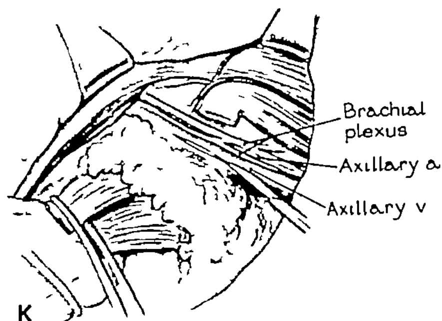

Line of axillary dissection
Tendon of insertion pectoralis minor m.
Biceps m. (short head)
Coracobrachialis m
Pectoralis minor m.
Pectoralis major m
J

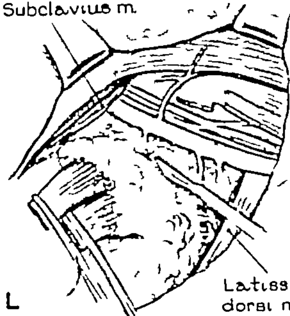
K. The axillary dissection cephalad to the brachial plexus is completed, and the fatty areolar tissue is turned downward over the brachial plexus and its encased axillary artery to expose the axillary vein. The skeletonization of this vein is begun by incising the overlying adventitia layer as shown.

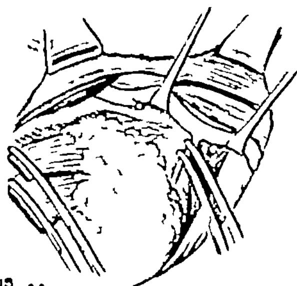
L, M. The mobilization of the breast mass is continued and the tributaries of the axillary vein and the branches of the axillary artery are doubly clamped, severed, and ligated (0000 silk) as they are exposed and isolated.

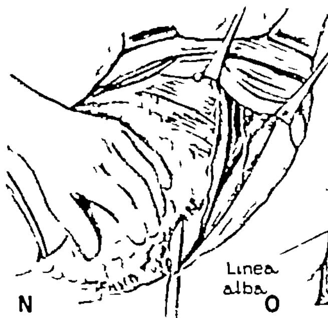
N, O. Upon completion of the skeletonization of the axillary vein, the fatty lymphoareolar tissue is cleared from the apex of the axilla, and scalpel dissection of the breast mass is continued onto the upper portion of the rectus abdominus muscle. Bleeding points in the muscle are occluded with suture ligatures of silk (000), and the scalpel dissection is continued upward onto the anterior chest wall (O).

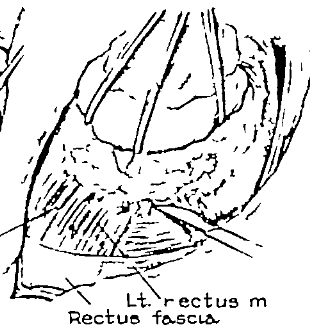
Plate 44


Brachial plexus
Axillary a
Axillary v
K


Subclavius m.
Latissimus dorsi m
L


M


N

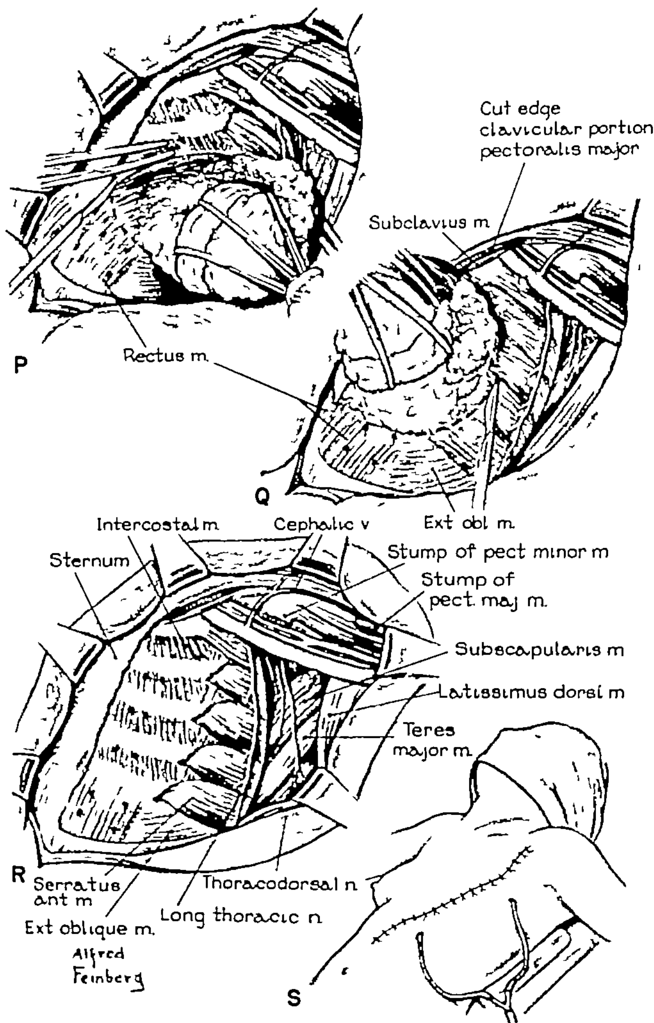

Linea alba
O
Lt. rectus m
Rectus fascia

P The breast mass is displaced downward and laterally and the sternal origin of the fibers of the pectoralis major muscle and the costal origin of the pectoralis minor muscle are severed by sharp dissection with a scalpel. During this dissection, the perforating branches of the internal mammary artery are first identified in continuity and then doubly clamped and severed In the event of bleeding from an accidentally severed perforating branch the immediate control of hemorrhage is best obtained by digital compression. Subsequently the severed vessel may be secured with a clamp the points of which are applied in a horizontal rather than a vertical plane to avoid a puncture wound into the subjacent pleural cavity

Q The remaining tissue attachments of the breast are severed from a lateral to a medial direction because of the better visualization of the cleavage plane between the breast mass and the fibers of the serratus anterior muscle

R. The operative field following the completion of the left radical mastectomy is shown. Although in this particular patient all of the nerves were spared, they are sacrificed with impunity if this is necessary to avoid leaving diseased tissue behind. Despite the location of the tumor in the medial quadrant of the breast, dissection of the internal mammary chain of nodes was not performed.

S. The primary closure of the skin flaps is completed, and the sites for the insertion of the catheters (18 F) are shown. The catheters are joined by a Y tube connection through which constant suction (Stedman pump) is applied for 72 to 96 hours This method obviates the need of pressure dressings and has proved much more comfortable for the patient. Primary closure of the incision is usually obtained. However it must be emphasized that one should never condone an inadequate removal of skin in order to obtain primary closure of the incision. To obviate such a tendency Follis suggested that the surgeon who performs the radical mastectomy should not be the one to close the incision. In this regard, the teaching of W Sampson Handley of England (the removal of an adequate area of the skin surrounding the tumor and the resection of a much wider area of the underlying fascia) is followed. This teaching differs from Halsted who advised the wide removal of a circular area of skin surrounding the tumor and the routine use of primary split thickness skin grafts of the Ollier Thiersch variety for the immediate closure of the skin defect.


Cut edge
clavicular portion
pectoralis major
Subclavius m
Rectus m
P
Q
Ext obl m
Intercostal m
Cephalic v
Stump of pect minor m
Sternum
Stump of
pect maj m
Subscapularis m
Latissimus dorsi m
Teres
major m
R
Serratus
ant m
Thoracodorsal n
Long thoracic n
Ext oblique m
Alfred
Feinberg
S

DISCUSSION—DR. WILLIAM CRAWFORD WHITE. Before entering into a discussion of the operative technic as shown by the drawings, it would be well to consider the problem of diagnosis of cancer of the breast. In early cases, this is often impossible without the aid of a biopsy. Tissue for diagnosis may be obtained either by a needle biopsy or an incisional biopsy. The advocates of the needle biopsy speak of its simplicity and convenience. Although admittedly this is true they neglect to say that a competent pathologist, who is completely familiar with this technic, is very necessary and furthermore that a negative report does not exclude the diagnosis of cancer.

The incisional biopsy which is the preferred method, is done at the time that the patient is in the hospital operating room and prepared for major surgery. The technic consists of skin incision, excision of the tumor, ligation of the bleeding vessels, followed by the closure of the wound which is done while the frozen section is under study by the pathologist. If the report is a benign tumor, the operation is over. If the pathologist is unable to make a diagnosis until the preparation of the paraffin sections is completed, the operation is also over, at least temporarily. However if the pathologist reports that the tumor is a cancer then it is indicated to proceed immediately with a radical mastectomy. Prior to this, a rubber dam is placed over the incisional wound and glued to the skin. The whole area is then resterilized, the gowns and gloves are changed, and a new set of sterilized instruments are used. We have demonstrated cancer cells on both the instruments and gloves after a biopsy of a malignant tumor. Accordingly, all this "fuss" is indicated to prevent the transplantation of cancer cells to the raw wound that is to be made.

The outline of the incision illustrated in Plate 42 (A) is excellent. It is wide of the tumor with a radius of at least two-and-one half inches from the tumor as suggested by Sampson Handley. Even after vigorous and widespread deep undercutting of the flaps, this means that in many cases the incision may not be closed primarily without the necessity for skin grafting. In my own experience about 30 per cent of my patients have required skin grafting. The advantage of this widespread removal of the skin is that one thereby reduces the percentage of local recurrences (or persistence) as we have demonstrated in a control series.

Drawings F and G, Plate 43, indicate well the method of isolating and separating the pectoralis major muscle from its neighbors. Many feel strongly that the whole of this muscle should be removed. Contrariwise, others have elected to leave in its clavicular portion in order to avoid the marked depression which occurs caudad to the clavicle when complete removal is practiced. It is believed that saving the clavicular portion does help the postoperative appearance of the chest and in my opinion it has not affected adversely the success of the operation.

Illustrations H, I, and J, Plate 43, demonstrate well the steps in cleaning out the axilla after the severance of the insertion of the pectoralis major. Perhaps it looks easier than it is. Certainly if one goes anterior to the axillary vein and then cephalad to it in order to clean out the area anterior to the brachial plexus, there will be more difficulty than usual, and furthermore the need for it has not been proved. The metastatic nodes ascend into the axilla and into the neck, both posterior and mesial to the brachial plexus. However when the growth is extensive and inoperable, there is a generalized involvement of the nodes in this region.

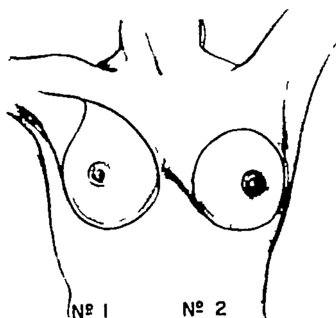
I personally like the technic illustrated in K, L, M, N and O, Plate 44, but it is doubtful if the removal of the rectus sheath is either indicated or necessary. In illustration N the nerves are shown intact. However if there is any doubt as to the complete removal of cells in the surrounding area because the nerves and vessels are left intact, one must not hesitate to sacrifice both the long thoracic and the thoracodorsal nerves as suggested by the author.

It will also be observed that the author has not excised the internal mammary nodes despite the fact that the tumor was located in the medial aspect of the breast. This procedure has been advocated by some competent surgeons, especially when the cancer is located in the mesial half or the central portion of the breast. The value of this additional step to the procedure of radical mastectomy, which is illustrated, is not yet established. It is still in the experimental stage and the proof of its value remains to be demonstrated. Instead, roentgen therapy could be administered to the mediastinum and the surgeon spared the increased mortality and morbidity that would result if the whole surgical community routinely undertook this procedure. It is also to be observed that those surgeons who do the mediastinal extension of the operation never do a skin graft and, therefore, I do not believe that they do a sufficiently radical procedure relative to the breast itself.

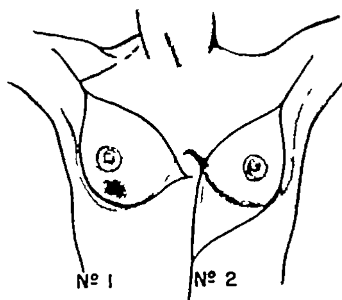
Another additional procedure in the performance of a radical mastectomy—the routine dissection of the neck on the same side when the axillary nodes are involved—was advocated by Halsted in 1894 and subsequently abandoned. Now it has been recently revived by Wangensteen and Dahl-Iversen. Time will be needed to check on their efforts. It is my present attitude that Halsted's belief that metastasis to the supraclavicular nodes was an index of incurability was correct.

At times, it may be possible to close primarily a large wound by first undercutting widely and deeply in all directions. Rodman used to undercut so far on the other side that after he had closed the wound, the remaining breast appeared to be in front of the sternum. He referred to it as the "Cyclops" operation. Later he claimed the breast would return to its normal position. Nevertheless, this method has some merit in avoiding the necessity for skin grafting. The addition of suction to the rubber tube drains, as suggested by the author, is believed an important contribution to the surgical technic for radical mastectomy.

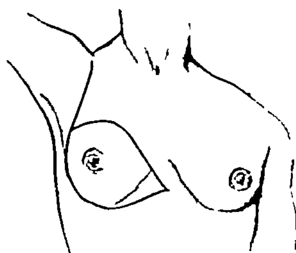
Plate 46

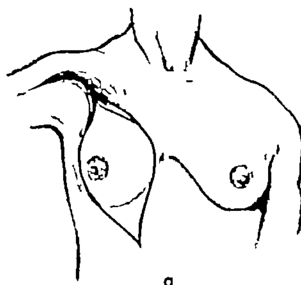


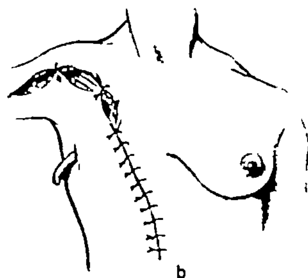
HALSTED

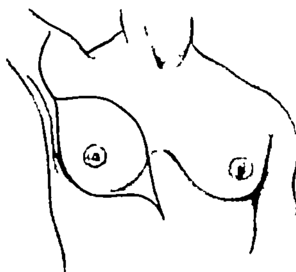


WILLY MEYER


KOCHER


a
DEAVER


b
DEAVER


HANDLEY

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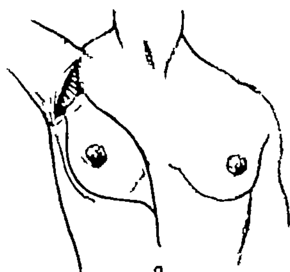
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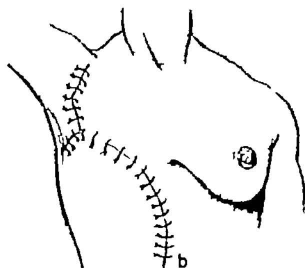
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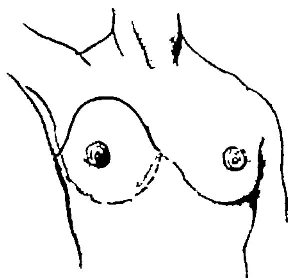
Plate 47



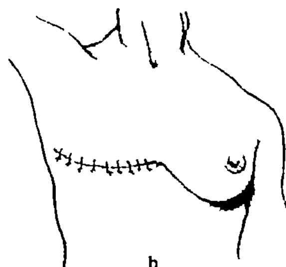
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RODMAN



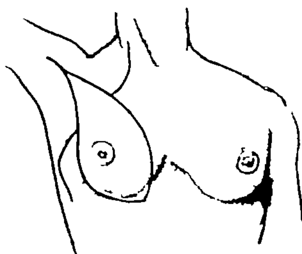
RODMAN



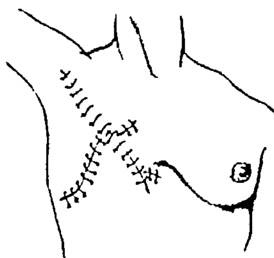
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STEWART



b
STEWART



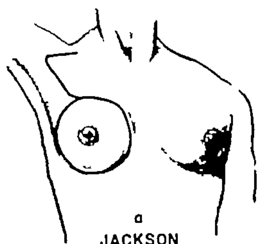
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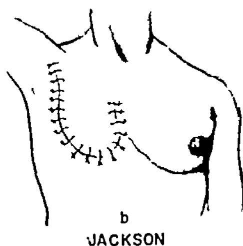
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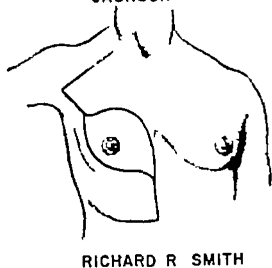
Plate 48



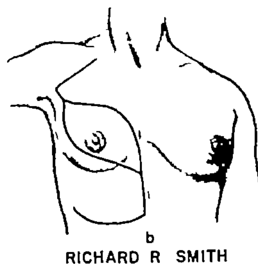
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JACKSON



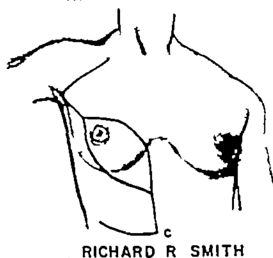
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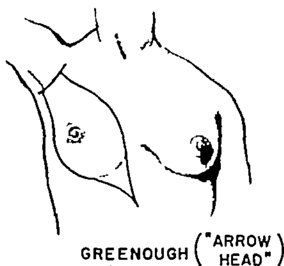
RICHARD R SMITH



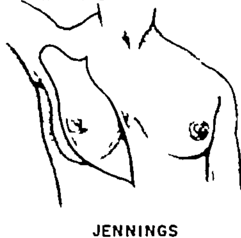
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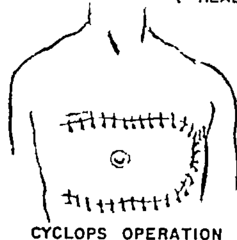
c
RICHARD R SMITH



GREENOUGH ("ARROW HEAD")



JENNINGS



CYCLOPS OPERATION

TRACHEOSTOMY

A tracheostomy may be performed either electively or as an emergency operation. Frequently it is done as an emergency procedure and, unfortunately, it is oftentimes performed too late. A good dictum to follow is that if the necessity for the performance of a tracheostomy is seriously questioned, it is usually a good indication for the operation. The technic for an elective tracheostomy is illustrated.

A. The two types of incision employed, the transverse and longitudinal, are indicated. The transverse incision is preferred.

B. The incision is deepened through the subcutaneous tissue plane, and its continuation through the fibers of the underlying platysma muscle is shown.

C. The upper and lower flaps of skin, subcutaneous fat, and platysma muscle are retracted and, with a scalpel, the anterior or investing layer of the deep cervical fascia is incised in the midline.

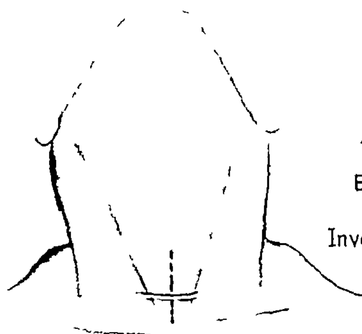
D. The sternohyoid muscles are retracted, and the underlying anterior borders of the sternothyroid muscles may be seen. An incision is made through the middle or pretracheal fascia layer of the deep cervical fascia to expose the isthmus of the thyroid gland.

E. The left finger of the surgeon is inserted downward beneath the pretracheal fascia, and the incision in this fascia is extended caudad by scissor dissection.

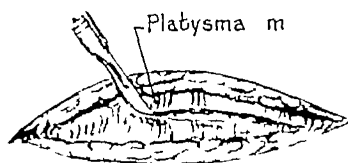
DISCUSSION—DR. EDGAR L. FRAZELL. The choice of the skin incision for tracheostomy is usually dictated by the circumstances of the individual case. When performed electively it is usually done as an integral part of some other operative procedure about the head and neck region.

The type of incision must then conform to the necessities of the primary operation. As an emergency measure tracheostomy is both dramatic and life-saving. Rapid exposure of the trachea with minimal dissection of skin flaps is imperative in such cases. I find this is facilitated by the use of the vertical midline incision as it minimizes blood loss from the distended veins in the area. Furthermore, the incision through subcutaneous tissue and fascia corresponds to the natural cleavage plane between the pretracheal muscles. Additional exposure is obtained by extension of the incision in either direction to allow for variations in the position of the thyroid isthmus. The latter structure may be retracted superiorly or inferiorly or rapidly divided between clamps to expose the second or third tracheal ring.

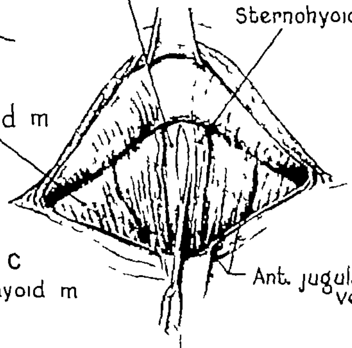
The important objective in an emergency tracheostomy is to establish an artificial airway in the shortest possible time. Simple incision of two or more tracheal cartilages is usually sufficient for introduction of the canula, though some surgeons prefer excision of a window. The latter technic tends to delay spontaneous closure of the fistula after the emergency is past. Suture of the wound about the tracheostomy may lead to troublesome subcutaneous emphysema in some cases and cellulitis in others.



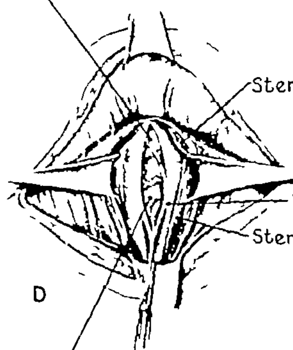
A


Platysma m

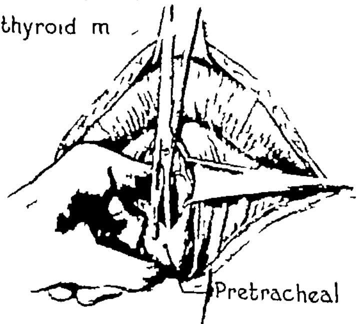
B


Investing fascia
Sternomastoid m

C


Cricothyroid membrane
Sternohyoid m
Pretracheal fascia
Sternothyroid m
Thyroid isthmus

D


Pretracheal

E

F The incision in the pretracheal fascia layer is completed and a portion of the trachea is exposed. The inferior border of the isthmus of the thyroid gland is grasped in anatomic forceps, and its attachment to the anterior surface of the proximal portion of the trachea is freed by scissor dissection.

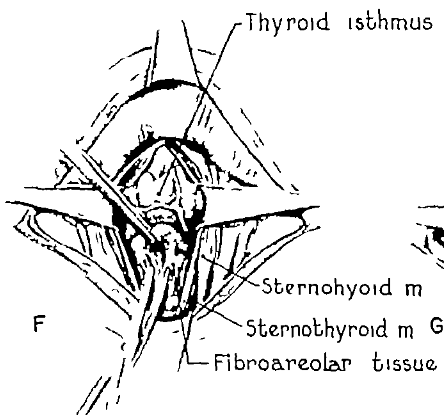
G The isthmus of the thyroid gland is retracted upward, and the oval segment of the trachea to be incised is indicated in dotted outline A segment of the third and frequently the fourth tracheal rings is included in this excision Entrance into the trachea above this level is avoided to prevent the subsequent occurrence of laryngeal stenosis. Immediately prior to opening into the trachea, 8 to 10 minims of cocaine (10 per cent) is injected into its lumen as depicted. This maneuver originally suggested by Sir St. Clair Thomson, lessens the cough as the tracheal lumen is entered

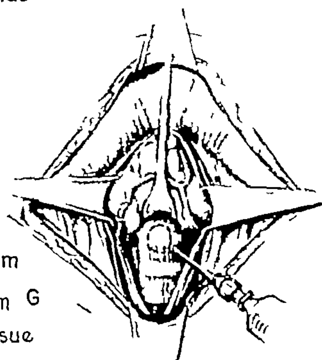
H, I. The severance of the remaining attachment of the oval segment of the anterior portion of the trachea is being completed (H) prior to the insertion of the tracheostomy tube (I). In the adult, the No 5 and No 6 tubes are the two sizes most commonly employed. In the infant child and adolescent, tubes ranging in size from No 0 to No 4 may be used.

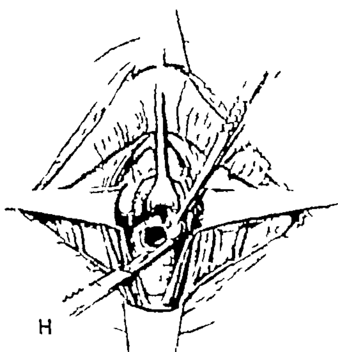
J The tracheostomy tube is inserted and the obturator removed to complete the operation. One or two skin sutures to approximate loosely the skin margins may be inserted. This type of wound is always potentially infected and accordingly a layer or tight closure of the incision is avoided. In some instances no sutures are used, the wound being covered by a moistened sterile split piece of gauze

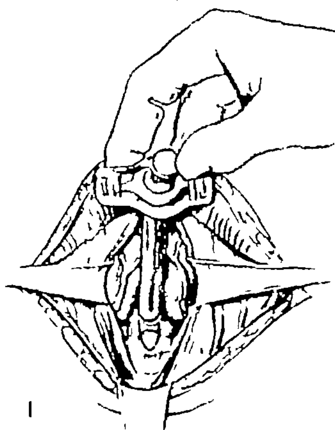
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Thyroid isthmus
Sternohyoid m
Sternothyroid m
Fibroareolar tissue
F


G


H


I


J

SCALENOTOMY

A. The site of the incision overlying the subclavian triangle of the neck is represented by a dotted line. This incision, located approximately 4 cm. cephalad to the clavicle, is bound anteriorly by the posterior border of the sternomastoid muscle and posteriorly by the external jugular vein.

B. The skin incision is deepened through the subcutaneous fatty tissue plane to expose the platysma muscle

C. The fibers of the platysma muscle are severed transversely and the incision in the anterior layer of the deep cervical fascia (investing layer) is visible.

D The clavicular belly of the sternomastoid muscle is retracted anteriorly and the incision in the middle layer of the deep cervical fascia between this muscle and the inferior belly of the omohyoid muscle is indicated by the dotted line.

E. The middle layer of the deep cervical fascia (omohyoid "fascial carpet") is incised, and the underlying fat pad, a characteristic anatomic landmark, is protruded into the incision.

F A portion of the fat pad is held in tissue forceps and displaced posteriorly to expose portions of the scalenus anterior muscle and the phrenic nerve A blood vessel accompanying the nerve may also be seen

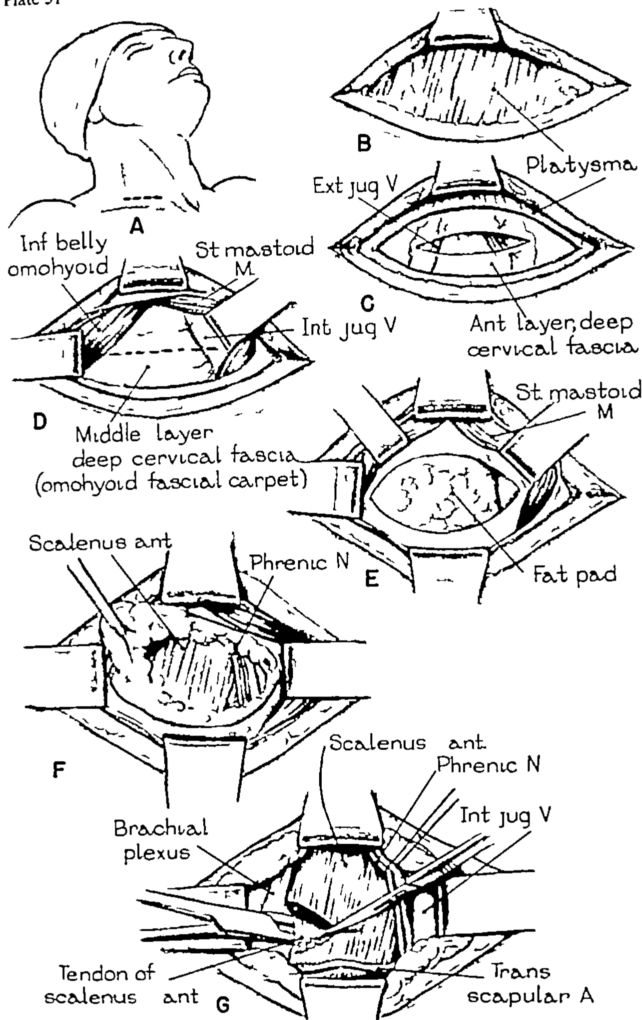
G. The lowermost portion of the scalenus anterior muscle is elevated on a clamp and the transection of its fibers in layers is begun. The internal jugular vein, the transverse scapular vessels, and the phrenic nerve with its accompanying vessel are demonstrable.

Discussion—Dr. James T Daniels. The apparently simple procedure of dividing a muscle such as the scalenus anticus can be appreciated as complex when the important structures lying in proximity to it are visualized. The illustrated technic of approach through the subclavian triangle to the scalenus anticus muscle demonstrates graphically the intricate relationship of these structures to the muscle It is essential to recall that the entire nerve and blood supply to the upper extremity and one-half the nerve supply to the diaphragm are contained within this small area, lying much deeper than it is possible to indicate in a two dimensional illustration. The maneuvering within this confined space is conducted with care in order to avoid injuring the adjacent structures.

From the viewpoint of operative surgery alone, relief of disturbing neurovascular symptoms due to compression by scalenotomy is achieved by knowledge of the anatomic relationship of the local and adjacent structures, proper exposure, and careful technic. Illustrations designed to serve as a guide for this purpose can be expected to fulfill these requirements. A knowledge of the normal anatomic arrangement of the elements present in the vicinity of the scalenus anticus muscle is presumed. The need for this knowledge is obvious when consideration is given the fact that lying nearby the scalenus anticus muscle and the structures contained within the precise boundaries of the subclavian triangle are the pleura, the carotid sheath and its contents, and the subclavian and jugular veins. For the careless operator there are many opportunities for disaster

Individual preferences based on experience suggest various considerations for slight alterations of technic. These variations present themselves by anticipating certain anomalies or abnormalities the surgeon may encounter in this region. For example, the anterior approach as illustrated is preferable to the lateral, particularly when a cervical rib of significant proportion is to be resected. In this instance a collar" incision passing 5 to 6 cm. upward and backward from a point slightly above the sternoclavicular articulation is advantageous. This affords exposure of the tendinous clavicular attachment of the sternocleidomastoid muscle Division of the clavicular attachment provides considerable space and exposure of the proximal portion of the subclavian artery and obviates difficult retraction. It is readily sutured with mattress sutures. The incision repre-

Plate 51


A
B
Platysma
Ext jug V
C
Ant layer, deep cervical fascia
Inf belly omohyoid
St mastoid M
Int jug V
D
Middle layer deep cervical fascia (omohyoid fascial carpet)
St mastoid M
E
Fat pad
Scalenus ant
Phrenic N
F
Scalenus ant
Phrenic N
Int jug V
Brachial plexus
Tendon of scalenus ant
G
Trans scapular A

H The transection of the remaining tendinous portion of the scalenus anterior muscle is about to be completed. In this regard, it is most important to sever completely all of the muscle and tendinous fibers to obtain complete release of the compression effect upon the subjacent subclavian artery

I The scalenotomy is finished, and the relation of the ends of the completely transected muscle to the surrounding structures is visible

J K. The fat pad is replaced, and the middle (J) and the anterior (K) layers of the deep cervical fascia are approximated with interrupted sutures of fine (0000) silk.

L. The skin is being closed with interrupted sutures of 000 silk. Each suture is threaded on a straight cambric or milliner's needle

DISCUSSION—DR. DANIELS (cont.)

sented in A, Plate 51 is well suited to this purpose by slight extension anteriorly The sternocleidomastoid and omohyoid muscles are retracted together as shown in Plate 51 (D). Only occasionally is it necessary to sever the omohyoid.

It may be suggested that, when the incision is made closer to the clavicle, the transverse cervical and suprascapular arteries will cross horizontally along the line of approach to the scalenus anticus muscle, *particularly its tendinous insertion. These are readily* isolated, clamped, severed, and ligated or electrocoagulated. At this low level, the phrenic nerve has, in coursing downward, obliquely crossed the scalenus anticus from its lateral to its medial border The nerve lies medial and may be difficult to find beneath the sternocleidomastoid muscle. It is readily found higher up and it should be identified, liberated, and displaced medialward where it can be protected for some distance.

In the lateral aspect of the exposure the brachial plexus is found emerging from behind the scalenus anticus muscle at its lateral border The surgeon must be aware that the distal portion of the subclavian artery lies inferior to the plexus, after arching posterior to the scalenus anticus muscle. This is illustrated in Plate 52 (I). Therefore it is signally important to anticipate possible injury to the subclavian artery Occasionally atheromatous plaques form on the vessel as the result of prolonged compression and irritation. Such plaques have been dislodged and fatal hemorrhage reported. If forceps are to be passed posterior to the muscle, it must be done with great care. My own preference is to free the plexus from the lateral border of the scalenus anticus muscle, to place a cotton strip upon the plexus, and to move it gently medialward as the muscle is divided in the same direction. Direct visualization is thus achieved and injury to the artery avoided. It is considered safer to sever the muscle in a piecemeal manner by grasping a few fibers in tissue forceps and carefully inspecting each group before sectioning with scissors.

Plate 52 (I) demonstrates the presence of a few fibrous adhesions attached to the inferior border of the arching subclavian artery These are occasionally situated about the vasa vasorum. If they are injured, troublesome extravasation of blood will occur between the muscular and adventitial layers of the subclavian artery This is best avoided by severing the fibrous adhesions some distance from the vessel.

The layers of the deep cervical fascia—the so-called "fat pad," which, incidentally harbors Virchow's lymph node on the right side—contain many fine blood vessels. These are disrupted in this procedure, and care must be taken to avoid oozing which will stain the surrounding structures, making identification difficult. They can readily be electrocoagulated, or if such a unit is not available, ligation may be necessary

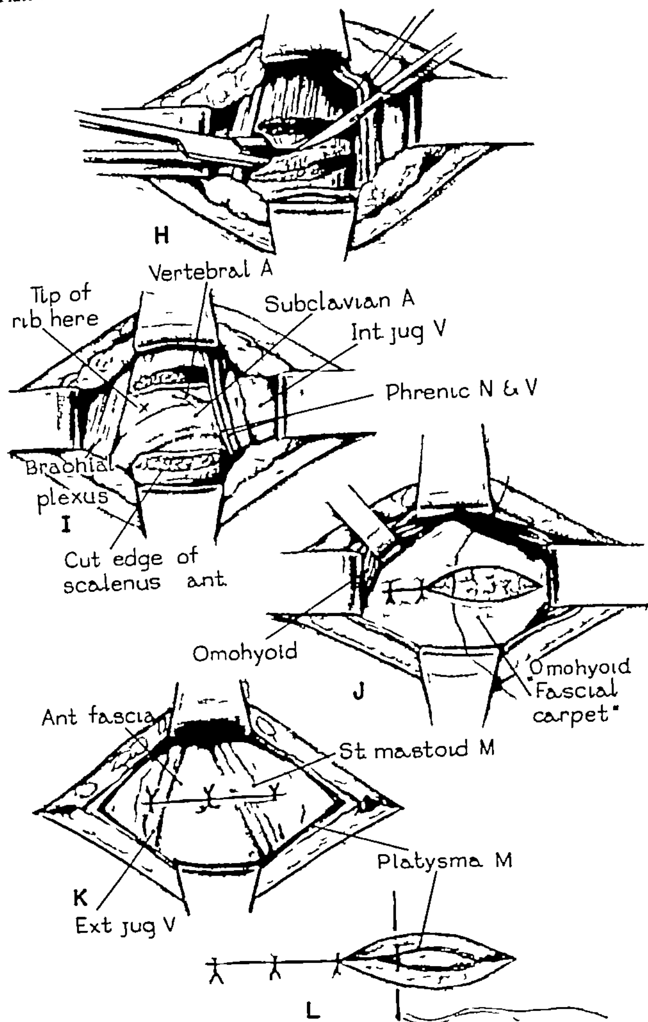
Irrigation of the operative area with warm saline, gentle suctioning, and the use of wet cotton strips or "paddies" used for sponging, quite satisfactorily serve the purpose of maintaining the normal appearance of tissues. When sectioning the scalenus anticus muscle, the oozing encountered can be minimized in this fashion, thus enabling the surgeon to identify precisely the structure he is about to divide

In closing the wound, in addition to the readily recognized necessity for closing the deep cervical fascia over the "fat pad" to avoid a troublesome postoperative "lump beneath the incision, two considerations are noteworthy They are, first, that a deeply placed suture near the clavicle can perforate the subclavian vein, and second, that an attempt should be made to avoid a resultant ugly scar especially in a female patient. The wound should, of course, be closed in layers, preferably with interrupted 0000 silk sutures as Doctor Madden suggests. This should include a subcuticular layer placed deeply enough to be well covered by the thin skin in this area.

A very careful skin closure with 000000 "arterial silk" and an "atraumatic needle" will afford accurate approximation of the wound edges and prevent an unsightly scar

REFERENCES (see page 636)

Plate 52


H
Vertebral A
Tip of rib here
Subclavian A
Int jug V
Phrenic N & V
Brachial plexus
I
Cut edge of scalenus ant.
Omohyoid
J
Omohyoid
"Fascial carpet"
Ant fascia
St mastoid M
Platysma M
K
Ext jug V
L

EXCISION OF THYROGLOSSAL DUCT CYST

A. A pillow support is placed in the midline posteriorly between the shoulders, and the head is hyperextended on the neck. The site *of the transverse incision between the hyoid* bone and the thyroid cartilage is indicated by the solid black line

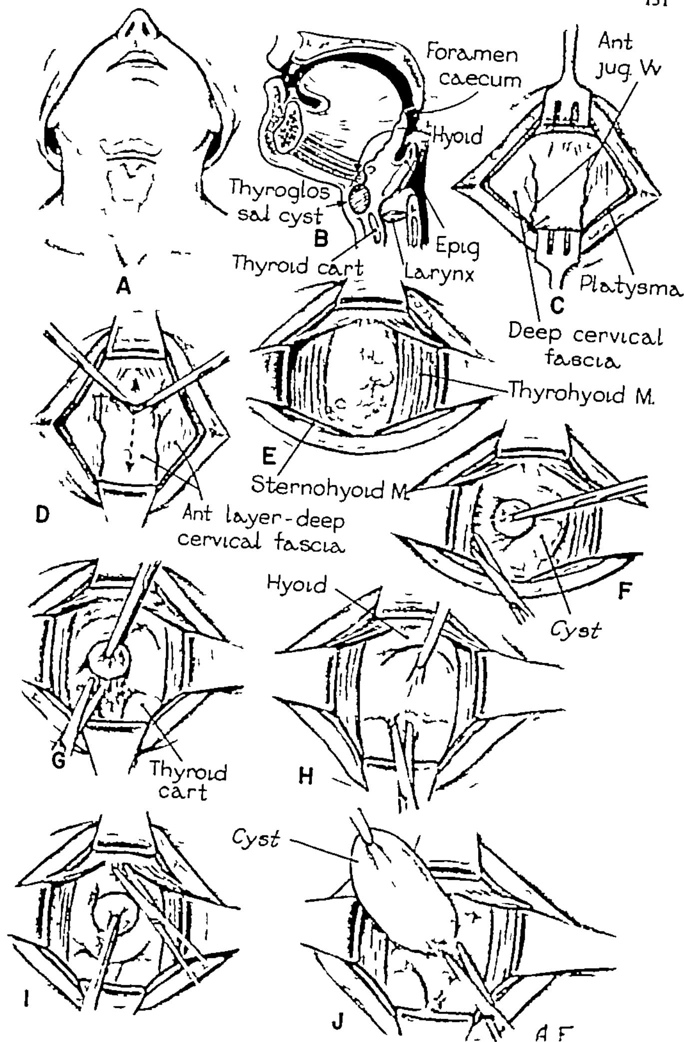
B. Sagittal view to show the relation of the cyst and sinus to the surrounding structures particularly the hyoid bone and the base of the tongue. The passage of the sinus through the hyoid bone and its opening on the base of the tongue at the foramen caecum are visible

C. The incision is deepened through the subcutaneous fatty tissue and the platysma muscle layers and the previously mobilized wound margins are retracted to expose the underlying structures.

D The incised margins *of the anterior or in-*vesting layer of the deep cervical fascia are grasped in clamps, and the extensions of the longitudinal incision in this fascia are indicated by the dotted lines and arrows.

E. *The sternohyoid muscles are retracted to* show both the prominence of the thyroglossal cyst in the midline and the subjacent thyrohyoid muscles laterally

F G H I, J The cyst is alternately displaced in various directions as the scissor dissection in the surrounding tissues is continued to mobilize completely the cyst down to its attachment to the hyoid bone.


Foramen caecum
Hyoid
Thyroglossal cyst
B
Epig
Thyroid cart
Larynx
A
Ant jug W
Platysma
C
Deep cervical fascia
Thyrohyoid M.
E
Sternohyoid M.
D
Ant layer-deep cervical fascia
F
Cyst
Hyoid
G
Thyroid cart
H
Cyst
I
J
A F

K. A portion of the wall of the summit of the cyst is grasped in a clamp and with downward traction on the cyst maintained, the transection of the hyoid bone with scissors is begun. In some instances the use of bone-cutting forceps for this transection may be required. The length of the segment of hyoid bone to be removed is indicated by the dotted lines.

L. The excision of a segment of the hyoid bone is completed, and the line of severance of the fibers of the mylohyoid muscles is shown by the dotted line.

M. The dissection of the thyroglossal duct within the fibers of the geniohyoid and the genioglossal muscles is completed, and a transfixion suture of silk (000) is being inserted through the cephalad part of the duct which will be transected immediately caudad when the ligature is tied

N The excision is completed, and a drain is inserted prior to closure of the thyrohyoid muscles. Neither the mylohyoid muscles nor the cut ends of the hyoid bone are approximated.

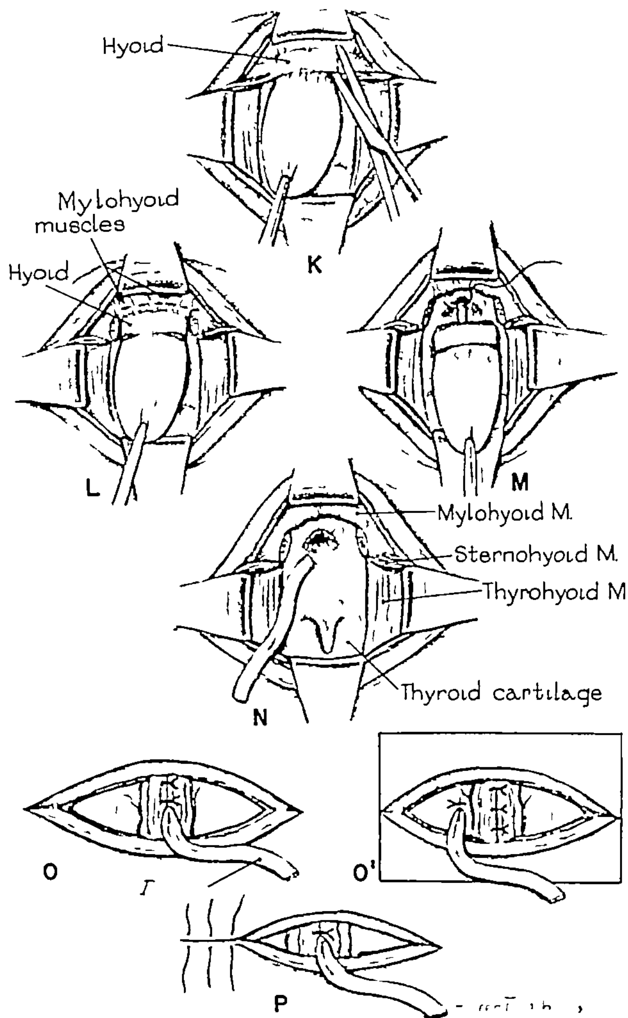
O O A drain is inserted through the line of closure of the muscles (O) or preferably through a lateral stab wound drain in the sternohyoid muscle (O')

P The skin incision is closed about the drain, using interrupted sutures of silk (000) The exit of the drain laterally rather than in the midline of the incision as depicted, is preferred.

Discussion—Dr. Edgar L. Frazell. Since the technic of excision of a thyroglossal duct cyst is so standardized, one wonders at the frequency of recurrence of these lesions It is probable that prior infection may hinder complete excision of all portions of the sac. Failure to excise a portion of the hyoid and any portion of the tract leading toward the foramen caecum are likely sources of error In jection of a few ml. of methylene blue into the sac preoperatively may be of value in some cases.

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Hyoid
Mylohyoid muscles
Hyoid
K
L
M
Mylohyoid M.
Sternohyoid M.
Thyrohyoid M
Thyroid cartilage
N
O
O'
P

A. The incision is outlined by pressure with a fine silk (0000) thread approximately 4 cm. above the suprasternal notch Previous to this three small cross hatch marks are made one in the midline anteriorly and each of the other two overlying the anterior border of either sternomastoid muscle The larger the gland the higher and the more transverse the incision

B C D The incision is deepened through the underlying platysma muscle and the upper flap is mobilized by a combination of first sharp and then blunt dissection to a level slightly above the superior notch of the thyroid cartilage. During this dissection of the upper flap one or two perforating vessels generally require clamping and ligation The importance of an adequate elevation of the skin and platysma flaps cannot be overemphasized. Dissection of the flaps beneath the platysma muscle, rather than in the subcutaneous tissue plane superficial to the muscle, is preferred.

E. The lower flap is mobilized both by sharp and blunt dissection downward to the level of the suprasternal notch. In the mobilization of the flaps, the main and most extensive part of the dissection is in the mid portion rather than in the lateral aspects of the incision If desired, either routine or selective transection of the prethyroid ("strap" or "ribbon") muscles may be employed as shown by the dotted lines (F) In this event, a preliminary dissection and retraction of the corresponding anterior border of the sternomastoid muscle is performed A high transection (upper third) of the muscles is performed to avoid injury to their nerve supply through the hypoglossal nerve. Clamps are not placed across the muscles prior to their severance as it is believed that they cause unnecessary tissue trauma. The anterior jugular and communicating veins are first ligated with suture ligatures of silk on either side of the proposed line of transection, and the muscles are then severed by scalpel dissection.

F The mobilization of the flaps is completed, and the incision in the anterior (investing) layer of the deep cervical fascia between the anterior jugular veins and overlying the line of junction of the sternohyoid muscles is shown in dotted outline.

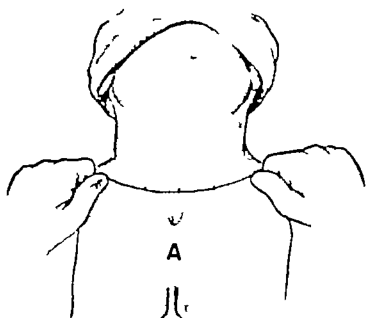
G The sternohyoid muscle, the superficial of the prethyroid or ribbon muscles, is retracted to expose the underlying deep ribbon muscle, the sternothyroid, and the line of incision in the middle layer of the deep cervical (pretracheal) fascia. This layer of fascia is frequently referred to as the "false" or "surgical" capsule of the thyroid gland.

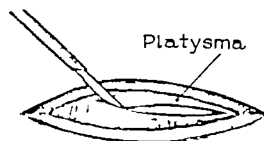
H Digital dissection is commenced in the plane beneath the pretracheal fascia or "surgical" capsule preparatory to the mobilization of the right lobe of the thyroid gland. This is believed a most important technical step in the operation because, if the proper plane of dissection is not entered, troublesome bleeding is most likely to ensue. The fibers of the sternothyroid muscle are intimately adherent to the thyroid gland, and their complete separation is required to facilitate its mobilization In the dissection laterally and posteriorly beneath the "false" capsule, particular care should be taken to avoid injury to the middle thyroid vein a tributary of the internal jugular vein.

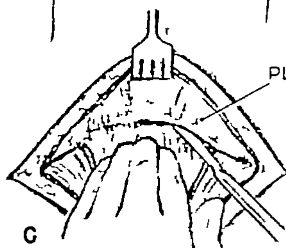
DISCUSSION—DR. LAWRENCE W SLOAN The routine thyroidectomy may be expeditiously carried out in steps essentially as illustrated. Recalling the fact, however that nothing in surgery is really routine and that, in the surgery of nodular goiter in particular one is usually operating because the suspicion exists that the goiter is malignant, the procedure must frequently be modified by the gross findings at operation and the knowledge one has about the likelihood of malignancy Today lobectomy is performed much more frequently than in the past. The reason for this is the greater awareness of the likelihood of cancer and the possibility of producing implants or spread of the cancer by needle or incisional biopsy The routine type of thyroidectomy is adapted especially for toxic diffuse goiter which is seldom malignant.

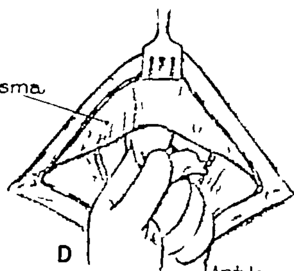
In dealing with any nodular goiter the surgeon should be aware of the possibility of malignancy In fact, except for actual or threatened compromise of the airway or because of clinical manifestations of toxicity the primary indication for operation is the belief that the nodular tumor is either malignant or potentially malignant.

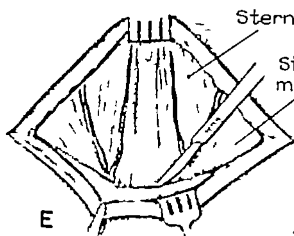
It must be remembered that if cancer is present in the gland, the field has been entered upon making the incision. After raising the flaps, the surgeon should be alert to the presence of lymph nodes which may

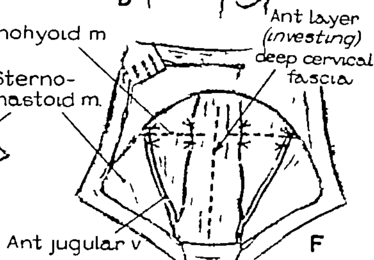

A

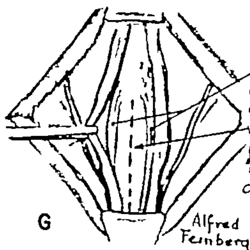

Platysma
B

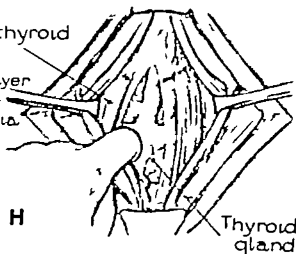

Platysma
C


D


Sternohyoid m
Sterno-
mastoid m.
E


Ant layer
(investing)
deep cervical
fascia
Ant jugular v
F


G
Alfred
Feinberg


Sternothyroid
m
Middle layer
deep cer-
vical fascia
(False or
'surgical'
capsule)
H
Thyroid
gland

I By digital retraction the right lobe of the thyroid is displaced toward the midline and the middle thyroid vein is doubly clamped prior to its division If desired, ligatures rather than clamps may be used. This is done before attempts are made to mobilize the gland. Otherwise an avulsion tear of the vein and troublesome hemorrhage may occur In some instances a second venous tributary may require ligation and division.

J The gland is displaced downward and to the left, and the ribbon muscles are retracted upward and to the right to expose the superior pole of the right lobe of the gland. Displacement of the gland by digital manipulation is generally preferred to the use of clamps which may tear the tissues and cause annoying hemorrhage Mobilization of the vascular pedicle of the superior pole is commenced by blunt dissection medially with a clamp inserted through an opening previously made in the fibroareolar tissue layer Subsequently the relatively dense layer of tissue posteriorly which binds down the superior pole, is incised as depicted by the dotted line. After incising this tissue the left index finger is inserted into the space behind the superior pole This space is bound posteriorly by the cervical vertebrae and laterally by the carotid artery By digital dissection in this space the superior pole of the lobe and its vascular pedicle may be completely mobilized

J J These insets depict the findings at operation in two successive patients and show the intimate relation of the external branch of the superior laryngeal nerve to the vascular pedicle of the superior pole of the thyroid lobe. It is believed that this relation has not been sufficiently stressed. This nerve accompanies the superior thyroid vessels in their descent toward the superior pole of the lobe. At a variable distance above this pole the nerve passes medialward in relation to the inferior constrictor and cricothyroid muscles. It lies on the surface of the cricothyroid muscle immediately subjacent to the line of insertion of the sternothyroid muscle into the thyroid cartilage and may be seen on elevation of the upper portion of this muscle In the application of clamps to the isolated vascular pedicle of the superior pole it is believed that this nerve should always be demonstrated to prevent injury to it. In fact, in one instance (J'), selective clamping ligation, and division of the superior thyroid vessels was necessary to avoid injury to the nerve. Several "blind" methods have been proposed for the avoidance of injury to this nerve during the dissection, isolation, and division of the superior thyroid vessels However none of these methods is absolutely safe because there may be anatomic variations in the distribution of the nerve which may be determined only by direct vision. In the performance of a thyroidectomy the importance of the proper identification and prevention of injury to the recurrent laryngeal nerve is repeatedly stressed. It is believed that the same should apply also to the external branch of the superior laryngeal nerve. Injury to this nerve, which innervates the cricothyroid muscle, causes a roughness, weakness, and early fatigue of the voice. Confirmation of the nerve injury is obtained by indirect laryngoscopy The affected cord will be lax and have an oblique, wavy concavity This is in contradistinction to the straight midline position of the affected cord, the so-called "cadaveric" position, in paralysis of the recurrent laryngeal nerve.

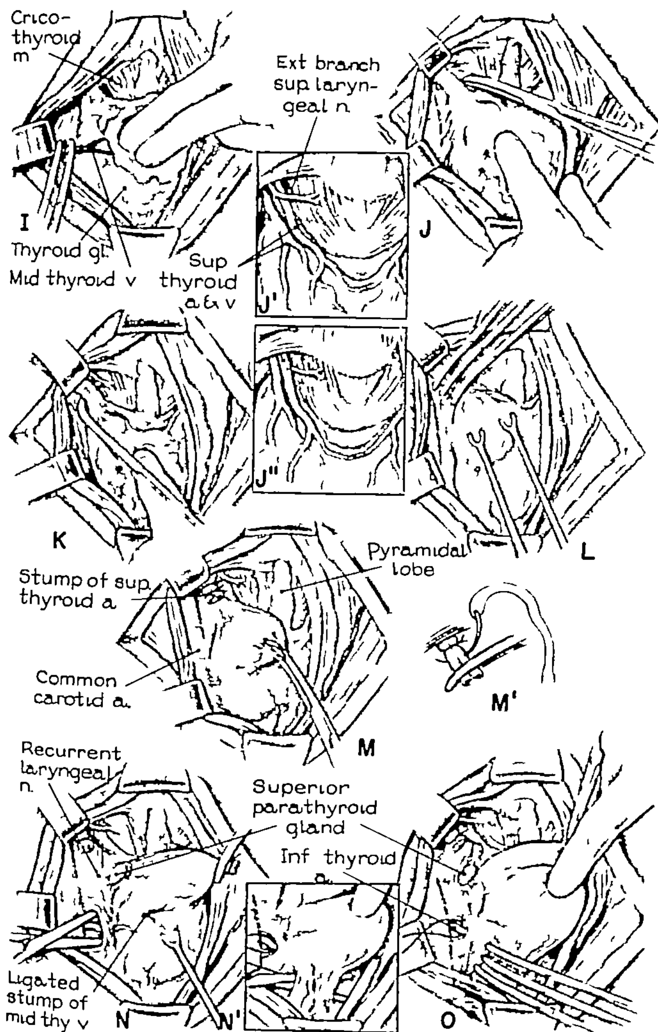
K L The vascular pedicle of the superior pole is isolated, and after proper identification of the external branch of the superior laryngeal nerve, the pedicle is triply clamped and severed between the two most distal clamps.

M M The proximal stump of the vascular pedicle is occluded with a proximal ligature and a distal transfixion suture ligature (M') of 00 silk. The relation of the external branch of the superior laryngeal nerve to the inferior constrictor and cricothyroid muscles and to the ligated stump of the superior thyroid vessels may be clearly seen.

N Dissection is commenced in the avascular areolar tissue space between the thyroid gland medially and the carotid artery laterally to expose the inferior thyroid artery The related surrounding structures are appropriately labeled.

N Inset to show the inferior thyroid artery encircled by an untied silk (00) ligature and the commencement of the isolation of the vascular pedicle of the inferior pole by clamp dissection.

O The isolated vascular pedicle is triply clamped, and the site of severance between the two proximal clamps is indicated by the dotted line


Crico-
thyroid
m
Ext branch
sup laryn-
geal n
I
Thyroid gl
Mid thyroid v
Sup
thyroid
a & v
J'
J
J''
K
L
Pyramidal
lobe
Stump of sup
thyroid a
Common
carotid a
M'
M
Recurrent
laryngeal
n
Superior
parathyroid
gland
Inf thyroid
a
Ligated
stump of
mid thy v
N
N'
O

P The mobilized superior and inferior poles of the right lobe of the thyroid gland are approximated, and the gland is retracted toward the midline The inferior thyroid artery is ligated in continuity and its two branches have been doubly clamped severed, and ligated in preparation for the total removal of the right lobe. In this patient the recurrent laryngeal nerve was located anterior to the inferior thyroid artery at the site of its bifurcation. The relation of this nerve to the superior parathyroid gland and its entrance into the larynx beneath the lower border of the inferior constrictor muscle is shown. This is immediately posterior to the site of articulation of the inferior horn of the thyroid cartilage with the cricoid cartilage.

P P′ These insets depict the alternate positions commonly observed in the relation of the recurrent laryngeal nerve to the inferior thyroid artery and its branches. The nerve may pass either between the branches (P′) or behind (P″).

Q The vascular fibroareolar tissue attaching the gland to the cricothyroid ligament and commonly called the suspensory ligament *is doubly clamped prior to its severance as* indicated by the dotted line.

[The operative technic illustrated up to and including this step is the same regardless of whether a total or subtotal lobectomy of the thyroid gland is performed.]

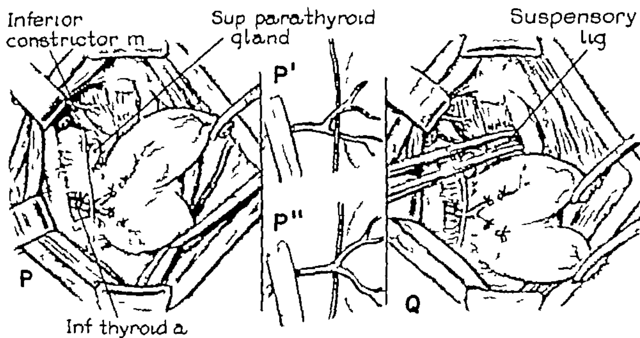
R R , R *These illustrations show the subsequent steps in technic for bilateral subtotal thyroidectomy (R′) and unilateral subtotal lobectomy (R″).* In the partial resection of a lobe (R) clamps are applied *to* the gland superiorly inferiorly and posterolaterally The clamps posterolaterally are inserted into the gland substance immediately proximal to the entrance of the branches of the inferior thyroid artery Only five or six clamps are required. Ligation in continuity of the main trunk of the inferior thyroid artery is routinely performed. The site of the incision for the subtotal resection of the right lobe is indicated by the dotted line. Following the completion of the resection, hemostasis in the remaining segment of the lobe is obtained by suture ligatures of silk (000) Similarly hemostasis in the clamped and severed isthmus (R″) will be obtained with suture ligatures of silk (000) Following the completion of either a unilateral or a bilateral *subtotal thyroidectomy the remnant of the* lobe is anchored to the pretracheal fascia with sutures of silk (000) as shown in R This particular step in technic is an aid in the control of bleeding from the cut surface of the gland.

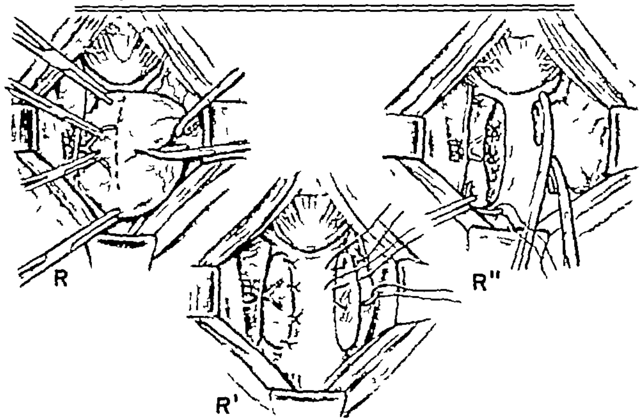
S, S The operation for total removal of the right lobe of the thyroid gland is now continued. A cleavage plane between the isthmus and the anterior surface of the trachea is obtained by blunt dissection, and the isthmus is serially clamped and severed as *demonstrated (S′)*

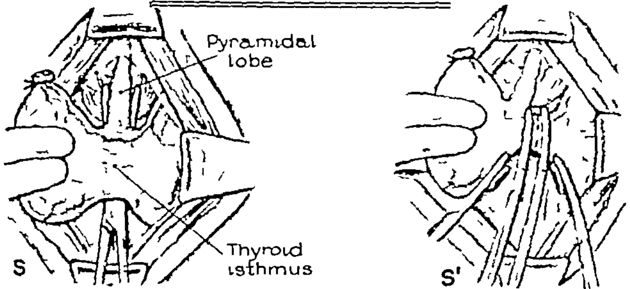
Discussion—Dr. Sloan (cont.)

first be found in the midline as the median raphe is incised and the sternohyoid muscles separated It is good practice in dissecting these muscles free to keep close to the under surface, leaving the thin fibroareolar tissue and nodes attached to the anterior surface of the gland (or to the "surgical capsule") to be removed with the specimen should the goiter actually turn out to be malignant. If in separating these muscles one of them should be found to be adherent to the gland, especially over a nodule, it would be important to excise the muscle *This will usually be the* sternothyroid muscle but, of course, both muscles may be removed without producing either undue deformity or disability Under such circumstances lobectomy should probably be performed and begun by transection of the isthmic part of the lobe which is thought not to be involved In such cases it is my practice to reflect the fragment of the uninvolved lobe together with the prelaryngeal and pretracheal fatty tissues (which contain lymph nodes) toward the side of the involved lobe (Figs. 1 and 2). The superior vessels are divided high, clearly identifying and often ligating them individually with fine silk If nodes are present alongside the vessels, they are included in the resected specimen.

The sternomastoid muscle is freed, and the carotid sheath is entered *The dissection is kept close to the* deep surface of the muscle so that any nodes within the sheath may be reflected toward the gland with the fascia. The nodes, if present, and the sheath over the internal jugular vein, vagus nerve, and common carotid artery are reflected toward the gland. Approaching the lateral posterior margin of the gland, the inferior thyroid artery is isolated, divided, and ligated, and the recurrent laryngeal nerve is identified. If the gland is malignant, the most common site of involved nodes will be the small lymph glands in close proximity to the primary tumor These nodes will be frequently found in the fatty paratracheal and paraesophageal tissues, paralleling and medial to the recurrent laryngeal nerve and follow the descent of this nerve into the mediastinum encircling sometimes


Inferior constrictor m
Sup parathyroid gland
Suspensory lig
P'
P''
P
Q
Inf thyroid a


R
R''
R'


Pyramidal lobe
Thyroid isthmus
S
S'

T U The severance of the isthmus is completed, and the clamps are replaced with hemostatic suture ligatures (00 silk). The previously mobilized pyramidal lobe is clamped, and the severance of its site of attachment is shown by the dotted line (U). This tissue attachment of the pyramidal lobe is clamped before it is severed because of the contained blood vessel normally present. For clarity the clamp is not shown.

V The right lobe of the thyroid gland is again retracted toward the midline, and the remaining attachment of the right lobe to the pretracheal fascia is severed by scalpel dissection.

W The operative field and the related structures following the completion of the total right lobectomy are depicted.

X Y The sandbags are removed from between the scapulae and the sternothyroid (X), and the sternohyoid (Y) muscles are approximated with interrupted sutures of 000 silk.

Z, Z′ The skin and platysma muscles are closed together as one layer (Z) and the application of a sterile dressing (Z′) completes the operation. In general, drains are not employed regardless of the size of the gland removed. However if the use of a drain is considered indicated, it is brought out between the fibers of the sternomastoid muscle as recommended by Lahey

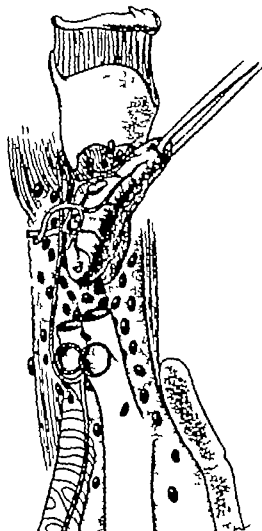
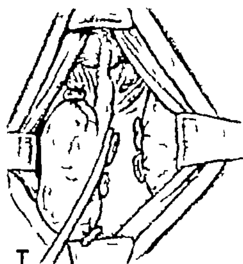


Fig 1 "Corner" of the gland and paraglandular spaces paratracheal, paraesophageal, paralaryngeal, anterior and superior mediastinal Note intimate relationships between recurrent laryngeal nerve and vessels especially at point of entrance of dividing nerve to intrinsic laryngeal muscles The fascialike structure suspending the gland at this point is often quite tough and dense Lymph nodes in the paraglandular areas are small but frequently involved in papillary or mixed cancer of the thyroid These are clustered about the gland and extend toward or into the superior and anterior mediastinum not infrequently just beyond the level which can be reached through the usual cervical incision

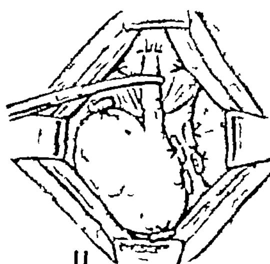
DISCUSSION—DR. SLOAN (cont.)

the trachea and the esophagus. These tissues are carefully dissected from the recurrent laryngeal nerve and the superior parathyroid gland, being careful to avoid compromise of the blood supply to this gland. The superior parathyroid gland is usually located anterior to the recurrent laryngeal nerve near its entrance into the larynx and accordingly it may be easily identified and preserved. However the inferior parathyroid gland is located among the nodes which should be removed with the specimen and cannot be as easily preserved without compromising the completeness of the dissection. The removal of the involved tissues is carried down as low as possible along the nerve and, occasionally on the right side, to its point of origin. Here, not infrequently involved nodes are found either during the neck dissection or during the mediastinal dissection performed subsequently if nodes along this route of spread have been found to contain cancer at the primary operation. The lobe, together with the paraglandular tissues described, is freed from the trachea and submitted to the pathologist. The diagnosis is usually established by gross and frozen section examination of the resected specimen. If the disease is benign, the neck incision is closed, usually without drainage. If it is malignant, the other lobe is removed together with the paraglandular tissue on the opposite side. The rationale for this step is twofold (1) Thyroid cancer is frequently multifocal and may be present even in microscopic foci in the grossly uninvolved lobe. (2) The likelihood that the nodes in the paraglandular areas closest to the primary focus will be involved is so great that a thorough dissection of these areas at a time when it can be done without undue risk of injury to the nerves and the parathyroid glands is most desirable.

The conventional neck dissection that is frequently performed for cancer of the thyroid gland metastatic to the cervical lymph nodes, does not take into consideration the important areas described above, because the operation was devised for metastatic cancer from primary lesions of the face, mouth, or pharynx. Malignant tumors originating in these sites do not spread along the routes which are most frequently followed in the dissemination of thyroid cancer from its primary site. The knowledge we now have about the spread of thyroid cancer must of necessity revise our ideas about the surgical procedures in dealing with this type of neoplasm. If cancer is found in the



T



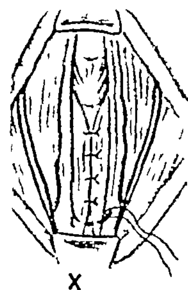
U

Ext branch sup laryngeal N
Sternohyoid m
Sternothyroid m.
Inf constrictor m
Cricothyroid m
Recurrent laryngeal N
Superior parathyroid gl.

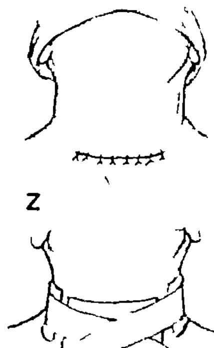
V

W

Thyroid gland
Trachea

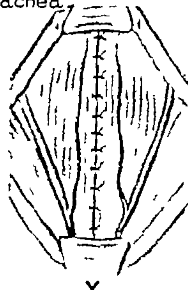


X



Z

Z'



Y

Alfred Feinberg

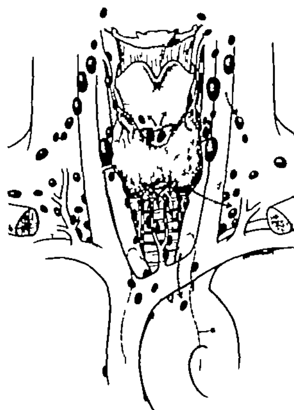


Fig 2. Routes of local and regional lymphatic spread of thyroid cancer There is little spread from the anterior aspect of the gland. The drainage appears to be along major vessels and nerves Distribution therefore occurs chiefly from the poles, along the posterolateral borders of the gland, and along the recurrent laryngeal nerves Mediastinal involvement when present is most dense near the lower border of the gland but often just out of reach through a cervical incision. Lymphatics encircle the trachea and esophagus particularly below the gland level so that occasionally para and retrotracheal and esophageal nodes will be found involved contralateral to the primary focus

DISCUSSION—DR. SLOAN (cont.)

surgical specimen, and these paraglandular tissues have not been removed, their subsequent removal will be a most important step in extirpating the disease. However such secondary operations will be fraught with the danger of injury to the parathyroids and the recurrent laryngeal nerve The removal of the paraglandular tissues is referred to as "clearing the gland area," which is most opportune to do at the time of the first procedure.

Other modifications of the large variety of routine procedures which may be used in doing a thyroidectomy are dependent upon the circumstances relative to a particular type of goiter In some instances division of the anterior thyroid muscles (Plate 55 E) is used, and in others, for example a large posterior mediastinal goiter a drastic modification of the operative technic may be required (Fig. 4). Knowledge of the anatomy involved is of particular importance in these somewhat exceptional situations because of the anatomic distortions or variations that are frequently present.

SUBSTERNAL, INTRATHORACIC, AND POSTERIOR MEDIASTINAL GOITER

Intrathoracic goiter is usually acquired. Substernal goiters are common and congenital aberrant goiters are rare.

The usual intrathoracic goiter is anterior: that is, it lies within the anterior mediastinum in front of the trachea and the great vessels. It may produce compression of the trachea, the esophagus, and the vessels from either before, backward, or obliquely at the level of the thoracic inlet (Fig. 3).

In the usual operation for intrathoracic goiter division of the "strap" muscles is generally desirable to provide good exposure. A good light is absolutely essential. Partial lobectomy of the smaller lobe is carried out first unless there is unilateral enlargement only of the gland. In that event, regardless of its size and consistency benignancy of the enlarged lobe should be questioned, and a total lobectomy should be performed. In any event, it is most important to free the superior part of the intrathoracic portion of the goiter before attempting its removal from the chest. This includes securing the superior thyroid vessels, division of the so-called suspensory ligament, transection of the isthmus of the gland, and, of equal importance, freeing the lobe to be resected from alongside of the trachea (Fig. 3). After accurately establishing the lateral plane of dissection on the surgical capsule of the gland, the lateral veins are ligated in this plane as they are encountered. Following this the intrathoracic portion of the gland can usually be eased upward and forward out of the chest. During this procedure, and especially before incising the surgical capsule laterally or inferiorly careful search should be made in a dry well illuminated field for an attenuated, displaced nerve. If found, it should be carefully freed and the lobe displaced toward the midline before resection. If this is done, the parathyroids also will usually be identified and protected from injury

Frequently a substernal goiter which is far more common than a truly intrathoracic goiter will be called intrathoracic, including the *goître plongeant.* However the operative technic is essentially the same as in a routine thyroidectomy A word about this technic should be said in relation to the large, "solid" variety of substernal goiter which, in a patient with a short, thick neck, may produce severe pressure on the trachea. Over a long period of time, this can produce softening of the tracheal cartilages to such a degree that tracheal collapse may occur either at operation or subsequently because the supporting effect of the thyroid is removed. A tracheotomy may be required and should be done if there is any question whatsoever about a competent airway An alternative procedure is occasionally available if the area of softening is detected at operation and if it lies close to the origins of the sternohyoid and sternothyroid muscles. Sutures from the origins of these muscles to the adjacent tracheal fascia may be employed to keep the softened wall from collapsing until the scarring and fixation of healing provide sufficient support for the trachea. If the area of compression is not in proximity to the muscle origins, collapse of the trachea will not

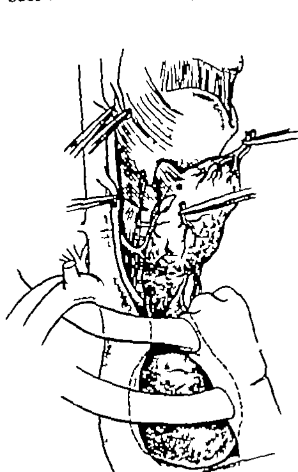


Fig. 3 The usual (anterior type) of intrathoracic goiter Freeing the superior pole, dividing the "suspensory ligament," the isthmus of the gland, and the tracheal attachments of the lobe to be removed are preliminary to delivering the intrathoracic part of the goiter The intrathoracic portion of the goiter lies anterior to the great vessels. Part of its vascular attachments may be in the mediastinum

"Corner" of the gland

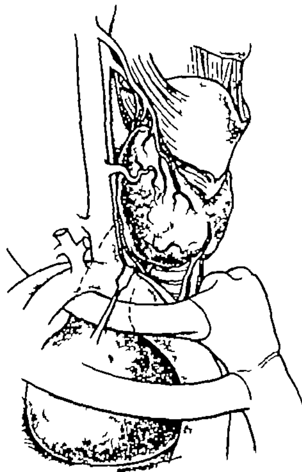


Fig 4 Posterior mediastinal goiter The cervical portion of the gland is often lower than shown. The mediastinal portion of the goiter is shown springing from the posterior aspect of the gland close to the trachea, thus displacing the recurrent nerve laterally into a vulnerable position The goiter lies posterior to the major vessels, displacing them forward. The trachea and esophagus are usually displaced forward and to the left All of these structures may also be compressed The internal and external branches of the superior laryngeal nerve are shown exaggerated to remind the surgeon of the proximity to the superior thyroid vessels

Discussion—Dr. Sloan (cont)

be prevented by suturing the tracheal wall to the muscles or to their aponeuroses and accordingly should not be done. The zone of compression in an intrathoracic goiter is usually at the thoracic inlet and in such instances the discusser has found the above described procedure of distinct value In determining whether there is softening and whether the expedient described is effectual, the cooperation of the anesthetist is essential. The endotracheal tube should be withdrawn slowly to a point just above the tracheal cartilages involved but not above the glottis. The area of softening may be easily detected by the surgeon feeling the trachea as the tube is moved.

In dealing with large goiters, especially if the enlargement is unilateral and associated with rotation of the trachea and larynx as well as displacement, one must always be aware of the possibility that the recurrent nerve may be stretched over the gradually expanding mass and lie in a vulnerable position. Under such circumstances, inadvertent injury to the nerve is not uncommon, especially if it lies in front of (or external to) the inferior thyroid artery and its branches rather than in its usual positions posterior (or medial) to the artery or between its branches.

In large goiters (and sometimes in small ones) the capsular veins are large and so fragile that they are easily torn, causing annoying and, at times serious bleeding, which may be a threat to the successful outcome of the operation. Securing the major vessels, particularly the inferior thyroid vessels, before resection is a recommended procedure, but at times in the attempt to expose these vessels, the bleeding from the large capsular veins may predispose to injury of the recurrent laryngeal nerve the parathyroid glands, and the internal jugular vein A maneuver which has been found helpful in such instances is to pass mass suture ligatures of fairly heavy material through the gland substance These are tied snugly and the ends cut long to use as retractors. The use of hooks and small shallow ligatures in these glands usually causes excessive bleeding because of the abundant network of superficial and friable veins.

DISCUSSION—DR. SLOAN (cont.)

Rarely in removing a large and adherent intrathoracic goiter the sternum may have to be split. However the maneuver described by Lahey many years ago may be employed in dealing with the usual type of nontoxic nodular intrathoracic goiter which is composed largely of colloid and degenerating thyroid tissue. The finger is inserted into the top of such a mass, breaking it up and removing enough of its contents so that the intrathoracic component can be compressed and delivered into the neck through the thoracic inlet. In this type of gland the risk of hemorrhage from this procedure is minimal.

Posterior mediastinal goiter a type of intrathoracic goiter which is not common, arises from the posterior aspect of the gland and extends as it enlarges downward into the chest *behind* the carotid sheath. In about 75 per cent of the cases, the downward extension is on the right side between the sheath and the trachea (Fig. 4). In those instances in which the gland lies low in the neck, the goiter may be entirely intrathoracic although usually there is a sizeable cervical component The intrathoracic extension, connected to the cervical goiter by a small and inconspicuous isthmus, may not be recognized at operation and only be discovered later by roentgenographic studies either incidental to or because of symptoms of tracheal or esophageal compression The differential diagnosis of these goiters is sometimes puzzling. Radioactive iodine studies have proved helpful. Expansion downward produces deviation of the trachea and esophagus forward and to the side opposite the goiter with or without compression. They sometimes attain a large size and may encroach significantly upon the upper lobe of the lung. The recurrent laryngeal nerve usually is in its normal location, but the extension of the goiter downward may begin low in the gland between the trachea and the nerve where it deviates from the trachea, especially on the right side. This position exposes the nerve to an added risk of injury a fact the surgeon should always remember

When small, a posterior mediastinal goiter can usually be removed through a cervical approach. In any event, if this type of goiter is suspected, even when large the initial approach should be made by the cervical route because of the location of the major blood supply which is in the neck. Exploration of the gland, determination of the position of the recurrent nerve control of the major vessels of the gland, and possibly even removal of the goiter through the neck wound may be accomplished by retraction of the carotid artery internal jugular vein, and vagus nerve in one direction and the trachea and the esophagus in the other One should recall, however that the intrathoracic component may have acquired or already possesses good sized vascular channels. Accordingly the surgeon should not persist unrelentingly in the attempt to remove the mass by this route but should remove it through a thoracotomy incision suitably placed It is obvious that splitting the sternum for removal of this type of goiter has not the same rationale as in dealing with the unusually large anteriorly placed intrathoracic goiters.

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RESECTION OF PHARYNGOESOPHAGEAL DIVERTICULUM

Diverticula of the esophagus are classified into two types traction and pulsion. Traction diverticula most commonly occur on the anterior wall of the midportion of the thoracic esophagus in the region of the tracheal bifurcation. These diverticula are secondary manifestations of a surrounding inflammatory reaction and are true diverticula in that they contain all of the coats of the esophagus. However this type of esophageal diverticulum is of little surgical significance.

The pulsion types of diverticula are most commonly found in the cervical region at the pharyngoesophageal level. They most commonly protrude on the left side, but they may be bilateral or protrude in the midline posteriorly They may occur infrequently in the lower third of the esophagus just above the diaphragm, the so-called epiphrenic diverticula, and protrude either toward the right or the left side in the posterior mediastinum. The pulsion type of diverticulum is classified as false in that the mucosa of the esophagus herniates through the layers of overlying muscle fibers, and accordingly the diverticulum does not consist of the whole thickness of the wall of the esophagus. In the cervical region this protrusion usually occurs in the space between the lowermost fibers of the inferior constrictor muscle of the pharynx and the fibers of the cricopharyngeus muscle. Occasionally the protrusion may occur through the uppermost fibers of the cricopharyngeus muscle.

Pulsion diverticula are more commonly found in males (4 1) and occur most frequently in the sixth and seventh decades However in the illustrated technic the drawings were from sketches made by the artist while observing the operation performed in a 30-year-old man who had symptoms of progressive dysphagia of 14 months duration.

A. The patient is anesthetized, using intratracheal anesthesia. The oblique linear incision employed, paralleling the anterior border of the sternomastoid muscle is depicted in dotted outline. Rarely a right-side approach may be indicated for the exposure and the removal of a pharyngoesophageal diverticulum.

B. The incision is deepened through the platysma muscle and the anterior or investing layer of the deep cervical fascia to expose the fibers of the left sternomastoid muscle.

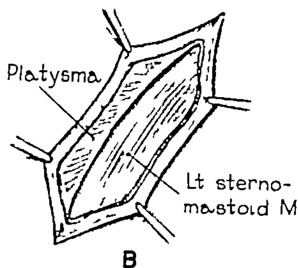
C. The anterior border of the sternomastoid muscle is mobilized and retracted laterally to expose the middle or pretracheal layer of the deep cervical fascia and its contained carotid sheath The adjacent muscle structures are depicted.

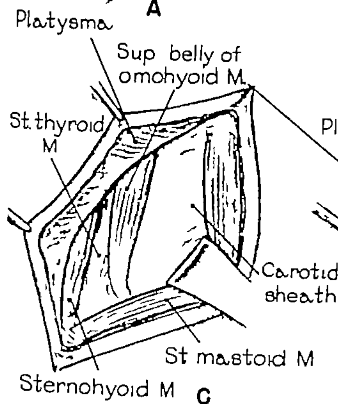
D The tendinous pulley uniting the superior and inferior bellies of the omohyoid muscle, *is elevated by a guy suture of silk (0)* and retracted downward and medially Severance of this tendon may be performed but this is generally not necessary The retraction of the superior belly of the omohyoid muscle medially exposes the posterolateral portion of the left lobe of the thyroid gland and its overlying fascial (pretracheal) covering.

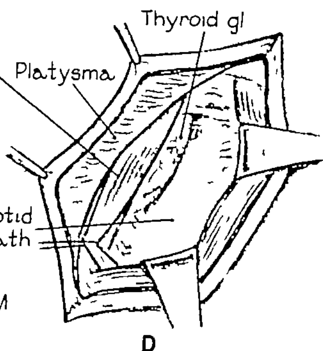
E. The middle or pretracheal fascial layer of the deep cervical fascia is incised to expose clearly the thyroid gland and the contents of the carotid sheath the internal jugular vein, the vagus nerve, and the common carotid artery In this patient there was an unusually large tributary vein as depicted which entered the internal jugular vein in the region conforming with the site of drainage of the common facial vein. Although it was in close approximation to the operative area, ligation and severance of this vein was not required.

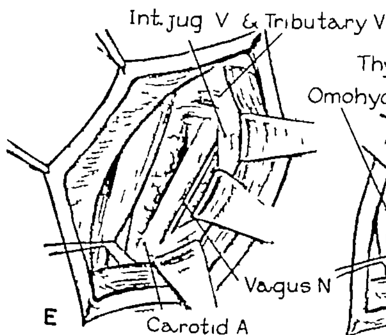
F The superior belly of the omohyoid muscle and the underlying sternothyroid muscle are retracted anteriorly and medially and the sternomastoid muscle and the structures contained in the carotid sheath are retracted posteriorly and laterally to expose more clearly the posterolateral aspect of the left lobe of the thyroid gland The inferior thyroid artery a branch of the thyrocervi*cal trunk of the subclavian artery* crosses horizontally beneath the carotid artery and divides into ascending and descending branches prior to its entrance into the gland structure The inferior thyroid artery is a useful landmark for the identification of a pharyngoesophageal diverticulum which is usually located immediately subjacent to this vessel.

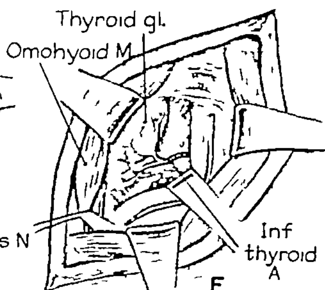

A


Platysma
Lt sterno-
mastoid M
B


Platysma
Sup belly of
omohyoid M.
St. thyroid
M
St mastoid M
Sternohyoid M
C


Thyroid gl
Platysma
Carotid
sheath
D


Int. jug V & Tributary V
Vagus N
Carotid A
E


Thyroid gl.
Omohyoid M
Inf
thyroid
A
F

G H The inferior thyroid artery is doubly ligated and severed (G) and the thyroid gland is retracted medially to expose the esophagus, the diverticulum, and the recurrent laryngeal nerve (H)

I The recurrent laryngeal nerve, encircled by a guy suture of silk (000), bifurcated just prior to its passage beneath the lowermost fibers of the inferior constrictor muscle and its entrance into the larynx. The identification and isolation of this nerve is important in the prevention of injury to it during the operative procedure. The diverticulum, covered by fibroareolar tissue, may be seen to protrude through the space between the lower border of the inferior constrictor muscle of the pharynx above and the fibers of the cricopharyngeus muscle below In some instances the protrusion may occur through the uppermost fibers of the cricopharyngeus muscle.

J K. A Babcock clamp is applied to the fundus of the partially mobilized diverticulum (J) and, with traction maintained through the clamp the mobilization of the diverticulum from the surrounding structures is completed by scissor dissection (K)

L. Inset showing a magnified view of the completely mobilized diverticulum and the demonstration of a technic for the determination of the level of the true neck of the diverticulum. In this particular patient the neck of the diverticulum appeared unduly wide in diameter Accordingly a catheter (16 F) was inserted through an opening in the fundus of the diverticulum and into the lumen of the distal portion of the esophagus where its tip could be readily palpated by the left index finger impinged against the outer wall of the esophagus. In this manner the true neck of the diverticulum was defined and the line for the resection indicated.

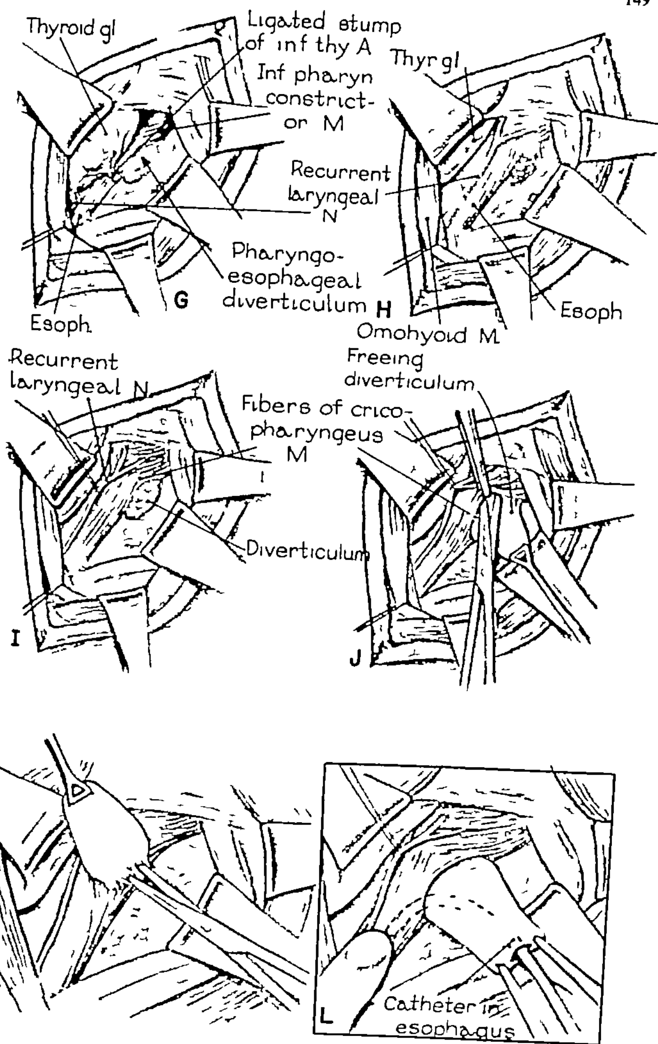
DISCUSSION—DR. KENNETH W WARREN. It has been an almost invariable practice at the Lahey Clinic to employ a long, oblique incision along the anterior border of the left sternomastoid muscle in approaching pharyngoesophageal diverticula. The choice of this type of incision is based upon the observation that one cannot prophesy preoperatively which diverticulum will be easily exposed, delivered, and dissected and which—because of its size, its adherence to the esophagus or related cervical structures—will prove to be difficult to manage Until recently the majority of pharyngoesophageal diverticula treated at the Lahey Clinic were removed by the two stage operation. The long, oblique incision placed along the sternomastoid muscle afforded ample opportunity in this two stage procedure to permit fixation of the fundus of the diverticulum high in the cervical region so that the most dependent portion of the diverticulum would be at the junction of the sac with the longitudinal esophagus. Over 90 per cent of esophageal diverticula currently treated at the clinic are excised in a one stage maneuver We still prefer this incision.

The skin and platysma are incised, and the anterior edge of the sternomastoid muscle on the left is reflected laterally thus exposing the anterior belly of the omohyoid muscle We have preferred to remove the anterior segment of this muscle completely rather than to retract it as is demonstrated in Plate 59 (D).

The advantages of removing this segment of the omohyoid (while it is not necessary in every instance) are very great. This maneuver exposes the internal jugular vein with its branches running to the thyroid gland. After division of these lateral thyroid veins, the left lobe of the thyroid is elevated and rotated anteriorly and medially thus exposing the common carotid artery which is then retracted laterally Retraction of the carotid artery affords access to the inferior thyroid artery which is then divided between clamps and ligated. This division permits a greater degree of mobility of the left lobe of the thyroid. The left recurrent laryngeal nerve is then identified and its entire cervical course is exposed, but manipulation of this structure is avoided insofar as possible.

The preceding maneuvers expose the region of the pharyngoesophageal diverticulum which can now be identified The fundus of the sac is grasped with Babcock forceps and the junction between the inner edge of the sac and the longitudinal esophagus is demonstrated. In some instances, the sac will be enveloped by a considerable thickness of fibers of the cricopharyngei which may make its identification difficult. In other instances, the sac may be extremely large and extend well down into the mediastinum. The delivery of such a large diverticulum from the mediastinum must be done with great care lest the diverticulum be perforated during this maneuver

It should be borne in mind that the pharyngo-


Thyroid gl
Ligated stump of inf thy A
Inf pharyn constrictor M
Recurrent laryngeal N
Pharyngo-esophageal diverticulum
Esoph
G
Thyr gl
H
Esoph
Omohyoid M
Recurrent laryngeal N
Diverticulum
I
Freeing diverticulum
Fibers of crico-pharyngeus M
J
K
L
Catheter in esophagus

M N Traction guy sutures of silk (000) are inserted through the neck of the diverticulum at its upper and lower borders, and the diverticulum is cross-clamped distally The excision is begun by scissor dissection (M) and, following a partial resection, the cut margins of the mucosa and the submucosa layers of the esophagus are approximated with interrupted sutures of silk (000). In excising the diverticulum, excessive traction on its distal portion should be avoided Otherwise the walls of the esophagus may be tented into the line of resection with resulting constriction of the esophageal lumen.

O The excision of the pharyngoesophageal diverticulum is completed, and the opening in the esophagus is closed with a series of interrupted sutures of silk (000).

O Inset to show an alternate method for the closure of the opening into the lumen of the esophagus The interrupted sutures of silk (000) are inserted from the "inside out" to the "outside in" so that, when tied, the knots of the sutures are on the inside of the lumen.

P Q The defect in the musculature through which the diverticulum protruded is closed with interrupted sutures of 000 silk (P), and a Penrose (cigarette) drain is inserted into the cervical mediastinal space (Q).

R. The left sternomastoid muscle is gently retracted to show the relation of the surrounding muscles previously labeled, to the carotid sheath and the site of drainage The large tributary of the internal jugular vein previously mentioned is visible in the upper angle of the wound

S. The operation is completed by closure of the skin incision about the drain, using interrupted sutures of silk (000)

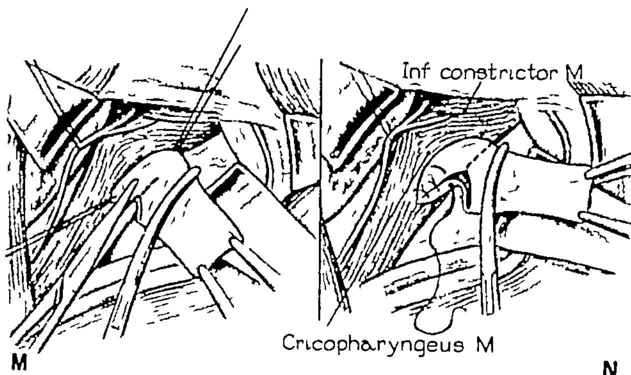
DISCUSSION—DR. WARREN (CONT.)

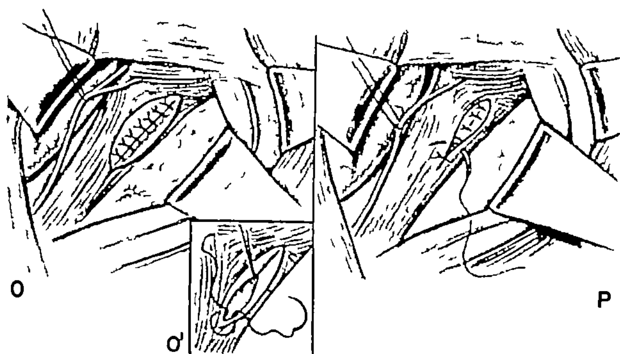
esophageal diverticulum prior to its dissection lies parallel to the longitudinal esophagus and that as the dissection of the sac from the esophagus is carried out, an acute angle is made by the junction of the neck of the sac with the longitudinal esophagus. If recurrence of the diverticulum is to be avoided, it is extremely important to dissect the neck of the sac completely It is easy to misjudge the degree of thoroughness of the dissection at this point, for the neck of the sac will be completely covered by an investment of the muscle fibers of the cricopharyngeus even though the sac has been liberated so that it hangs by its neck. We have always made it a point to dissect the neck of the sac until the pale white fibers of the submucosa of the sac are clearly visible. This dissection is relatively easily achieved in the inferior superior and left lateral positions. Unfortunately dissection of the right side of the neck is more difficult since the fixed position of the cricoid cartilage and of the pharynx makes it impossible to rotate the posterior wall of the pharynx sufficiently to see the right lateral wall of the sac directly except in those instances in which the diverticulum is very small and the neck quite narrow If this phase of the dissection is done with care and with appreciation of the anatomic relationships and of the embryology of these diverticula, there will be no difficulty in determining the site of the junction of the diverticulum with the longitudinal esophagus

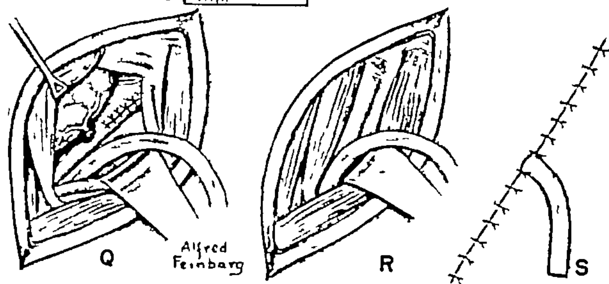
When the sac has been thoroughly mobilized as previously described, one must decide how to deal with the neck of the sac If the diverticulum is small or only moderately large and the neck is narrow it is reasonable to ligate the neck of the sac flush with its junction with the longitudinal esophagus, using a 00 chromic catgut ligature. A clamp is then placed distal to this ligature and the sac is amputated, leaving an adequate amount of stump to insure that it will not retract through the previously placed ligature When the neck of the sac is broad, it is best to divide its neck slightly distal to its precise junction with the longitudinal esophagus, and to close the defect with a continuous Connell inverting suture of fine catgut reinforced by a row of interrupted sutures of the same material. It is quite permissible to close this defect with interrupted sutures but we prefer to use inverting sutures, even though they be interrupted. After amputation of the sac and closure of the esophagus either by ligature or by the inversion suture method, it is important to approximate the cricopharyngei muscles over the closed neck of the sac. We usually employ a cigarette drain and bring it out in the lower angle of the incision

This comment has been limited to the one stage procedure However it is well to remember that the two stage procedure still has merit in the presence of the large pulsion diverticulum of the pharyngoesophagus when the sac extends well down into the mediastinum and when diverticulitis and peridiverticulitis are prominent features. The two stage procedure should also have considerable appeal to those surgeons with a limited experience in esophageal surgery who nevertheless, undertake to operate on pharyngoesophageal diverticula

REFERENCES (see page 636)


Inf constrictor M
Cricopharyngeus M
M
N


O
O'
P


Q
Alfred Feinbarg
R
S

CONGENITAL ATRESIA OF THE ESOPHAGUS WITH TRACHEOESOPHAGEAL FISTULA

A. The patient is placed in the direct left lateral prone position, and the right thoracotomy incision is indicated by the solid line. A transpleural rather than an extrapleural approach is preferred.

B. The right pleural cavity is entered, and the azygos vein is severed between ligatures of silk (000). The site of the tracheoesophageal fistula and the adherence of the narrow proximal end of the lower portion of the esophagus to the widened cul-de-sac formed by the distal end of the proximal portion of the esophagus are shown.

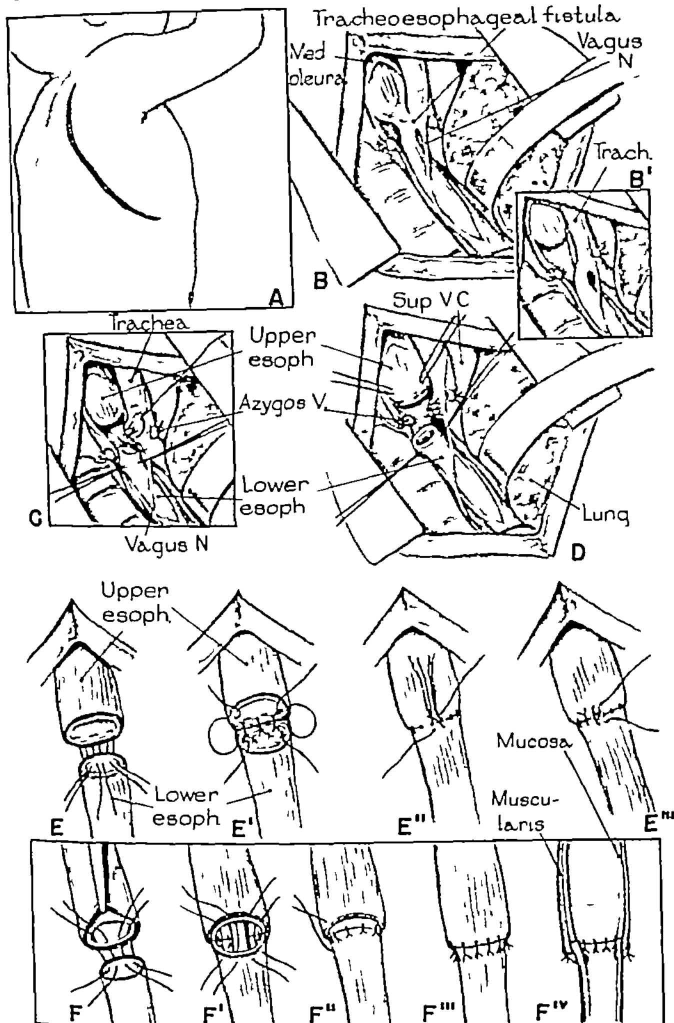
B¹ Similar view as in B in a patient in whom the distance between the esophageal segment is greater To bridge this distance the upper rather than the lower segment is extensively mobilized because otherwise there would be danger of compromise of the circulation to the lower segment.

C. The proximal end of the lower portion of the esophagus is severed in an oblique plane from its communication with the trachea, and the opening into the tracheal lumen is closed with interrupted sutures of silk (0000) which are swedged on minimum trauma needles To obtain an adequate sized diameter of the lumen of the lower segment, a resection of a narrow portion of its proximal end, although not shown, is usually required.

D The closure of the opening in the trachea is completed and traction guy sutures of silk (000) are inserted in the walls of the proximal and distal segments of the esophagus preliminary to the performance of the end-to-end anastomosis. The site of the incision to be made into the lumen of the proximal segment is indicated by the dotted line

E, E¹ E¹¹ E¹¹¹ These close up views depict the details of the end-to-end anastomosis of the esophagus The first posterior layer consists of a series of interrupted mattress sutures which are all first inserted before being tied (E). These sutures produce an inversion of all of the layers of the esophagus into its lumen The mattress sutures are tied and interrupted sutures of silk (000) which include all the layers of the esophagus are inserted and tied. These sutures form the second posterior layer of the anastomosis (E¹) and are continued anteriorly as the first anterior layer Although not shown in the illustrations, before inserting the first anterior layer of sutures an intraluminal catheter (No 8F) is inserted to facilitate the completion of the anastomosis anteriorly When this is done the catheter is removed. The sutures forming the first anterior layer are inserted from the "inside out" to the "outside in" so that when tied the knots are on the inside of the lumen (E¹). Each suture is inserted alternately from either end toward the center to avoid an angle closure of the anastomosis When the last two sutures are tied in the midline anteriorly they are encircled by a reinforcing figure of 8 mattress suture of silk (000) before being cut (E¹¹). The mattress suture is tied and the long ends are cut to complete the first layer of the anastomosis. For the second anterior layer interrupted horizontal mattress sutures of silk (000) are used (E¹¹¹). These sutures are inserted at right angles to the longitudinal layer of muscle fibers of the esophagus to obtain maximum holding power

F F¹ F¹¹ F¹¹¹ F¹ᵛ This series of close-up views illustrates the "telescoping" technic described by Haight in the performance of an end to-end anastomosis of the esophagus Interrupted sutures of silk (000) are used for the first posterior layer These sutures are all first inserted before being tied and include the mucosa layer only of the dilated proximal end of the esophagus and all of the layers of the narrow distal end of the esophagus (F) A catheter (No 8F) is passed from the lumen of the upper segment of the esophagus into the lumen of the lower segment and a similar series of sutures is inserted anteriorly (F¹) to complete the first anterior layer of the anastomosis (F¹¹). The second layer of the anastomosis, both anteriorly and posteriorly consists of a series of interrupted sutures which are inserted through the muscular layer only of the upper segment of the esophagus and through the whole thickness of the wall of the lower esophageal segment caudad to the level of the first layer of sutures (F¹¹ F¹¹¹) When tied, these sutures produce a "telescoping" of the narrow distal end of the esophagus into the wide proximal end which is best illustrated by a sagittal view of the completed anastomosis (F¹ᵛ)


Tracheoesophageal fistula
Med pleura
Vagus N
Trach.
A
B
B'
Trachea
Upper esoph
Sup VC
Azygos V.
Lower esoph
Lung
Vagus N
C
D
Upper esoph.
Lower esoph
Mucosa
Muscularis
E
E'
E''
E'''
F
F'
F''
F'''
F''''

In the surgical management of congenital atresia of the esophagus, the selection of the mode of surgical approach is determined mainly by the plain roentgenogram of the abdomen. In the absence of gas shadows in the gastrointestinal tract, a primary anastomosis of the esophagus is not considered. A primary esophagogastrostomy employing a right transpleural approach is preferred. In the presence of gas shadows in the gastrointestinal tract, an extrapleural thoracotomy on the right side may be employed, and, if possible, a primary anastomosis of the esophagus is performed. However in a certain percentage of the patients in this group a primary anastomosis of the esophagus may not be possible because of the wide separation of the esophageal segments If this should obtain, a transpleural extension of the incision is recommended and the stomach mobilized into the right pleural cavity If following the mobilization of the stomach, the distal end of the esophagus is viable and the diameter of its lumen is adequate a direct anastomosis of the esophagus may be performed. Otherwise, a primary intrapleural esophagogastrostomy is preferred. It is believed that every attempt possible should be made to reestablish continuity of the alimentary canal before resorting to a lifesaving multistage procedure.

Discussion—Drs John M Beal and Cranston W Holman Prematurity and aspiration pneumonia may present serious problems in the newborn infant who requires surgical correction of this congenital defect. For this reason, judicious preoperative preparation for 24 to 48 hours with antibiotics and parenteral fluids is usually indicated.

A right lateral transpleural approach through the fourth intercostal space gives the best exposure and requires less time. These are important considerations in operations upon small patients. To facilitate the anesthesia, the first step in the operation is to occlude the tracheoesophageal fistula which may easily be done by passing a small tape around the lower esophageal segment just below the tracheal communication. This prevents loss of the anesthetic agent, improves the respiratory exchange and materially aids the anesthesiologist in the management of the patient.

The text has emphasized adequate mobilization of the esophagus. An anastomotic breakdown is more likely due to excessive tension than to the impairment of the blood supply resulting from mobilization of the esophageal segments. After the closure of the tracheal opening and completion of the esophageal anastomosis, it is desirable to place a flap of pleura between the esophageal suture line and the tracheal closure This may be helpful in the prevention of a recurrence of the fistula.

A gastrostomy should be performed when the chest is closed. This permits early feedings which provide adequate nutrition until the oral intake is sufficient to satisfy the bodily needs. The operation is readily accomplished through a short left upper quadrant incision A No 12 F catheter is inserted through a small incision in the stomach wall which is encircled by a pursestring suture of 000 silk The stomach should be attached to the peritoneum of the anterior abdominal wall with two or three sutures of the same material. The incision is closed about the gastrostomy catheter with 000 chromic catgut.

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ESOPHAGOCARDIOMYOTOMY

A B. The peritoneal cavity is entered through an upper left rectus muscle splitting or muscle retracting incision (A) and the underlying intraperitoneal viscera are demonstrable (B)

C. By manual retraction overlying a protective moist gauze pad the peritoneal attachment forming the left triangular ligament of the liver is made taut and severed as indicated by the dotted line.

D The mobilized left lobe of the liver covered by a moist gauze pad, is folded downward on itself and retracted medially to expose the opening in the peritoneal fascial layer overlying the esophagocardial junction. The lower end of the esophagus, the vagus nerves and the esophageal hiatal ring formed by the superficial and deep muscle bundles of the right crus are visible. The tapered and thinned out terminal portion of the esophagus and the dilatation proximally characteristic findings in achalasia, may also be seen.

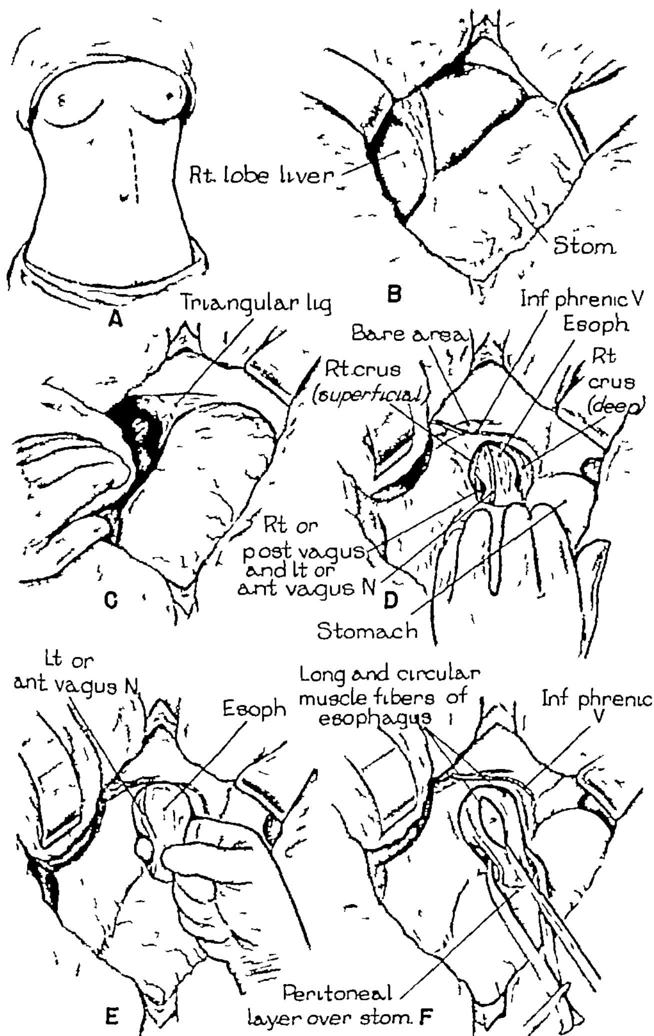
E. By careful digital manipulation within the posterior mediastinum, the lower portion of the esophagus is mobilized and displaced downward into the peritoneal cavity

F The esophagus at the level of the esophagocardial junction is encircled by a tape of rubber tissue and with downward traction maintained a linear incision through the fibers of the longitudinal muscle layer of the esophagus and the adjoining segment of the stomach is begun

Discussion—Dr. Richard H Sweet The operation of esophagomyotomy may be performed either through an abdominal incision, as originally advocated by Heller or through a left thoracotomy incision. In my opinion the latter is preferable for the following reasons (1) The incision through the left eighth intercostal space can be easily and quickly made and closed. (2) The exposure of the lower esophagus is more easily obtained, and access to the entire length of the lower segment is secured without dissection and mobilization which must always be employed when the abdominal approach is used. This makes it easier to avoid the vagus nerves and to minimize the amount of trauma in the lower esophageal region. (3) The fascial layers in the esophageal hiatus of the diaphragm are not greatly disturbed. (4) It is simple, using this approach, to repair a coexisting hiatus hernia with a minimum of dissection.

A technical matter which may make the difference between success and failure in the use of this operation for the treatment of megaesophagus is the length of the myotomy incision As shown in Plate 64 (F), this incision must extend upward on the esophagus to a point where the diameter of the organ is large It is not necessary on the other hand, to extend the incision onto the wall of the stomach below the cardia. No hypertrophied circular muscle fibers are ever found distal to this point. It must be remembered that the abnormality is in the esophagus. The unnecessary extension of the incision into the stomach wall below the cardia usually is harmless, but because the muscular layers there are thin, it is easy to penetrate the mucosal layer If this accident should occur a careful closure of the opening should be made with sutures of fine silk.

The dissection between the circular muscle layer and the submucosa as shown in Plate 65 (H and I) is unnecessary and might even be harmful. It is much easier and safer merely to cut through the muscle layers with a sharp knife It is absolutely essential, however to divide every single circular muscle fiber in order to avoid leaving a stenotic point. Plate 65 (J) shows the appearance of the bulging mucosal layer when the division of the muscle has been completely accomplished, although in my opinion the incision as illustrated extends unnecessarily far into the wall of the stomach.


Rt. lobe liver
Stom
A
B
Triangular lig
Inf phrenic V
Esoph
Bare area
Rt crus (superficial)
Rt crus (deep)
Rt or post vagus and Lt or ant vagus N
C
D
Stomach
Lt or ant vagus N
Esoph
Long and circular muscle fibers of esophagus
Inf phrenic V
Peritoneal layer over stom.
E
F

G The incision through the longitudinal muscle layer of the esophagus is completed, and the underlying layer of circular muscle fibers is visible. A vessel crossing transversely at the level of the cardia is shown elevated on a clamp prior to its double ligation and severance.

H, I. Following the completion of the incision in the longitudinal muscle layers of the esophagus, the cardia, and the segment of the gastric wall immediately below the cardia, the underlying circular layers of muscle fibers are elevated in segments and severed by scissor dissection.

J K. The esophagocardiomyotomy is completed and the herniation of portions of the mucosa of the esophagus the cardia and the adjacent segment of the stomach respectively are depicted. The prominence of the vessels in the submucosal layer of the stomach may also be seen.

L, M, N The wound is closed in layers using a double strand of a continuous interlocking suture of 00 chromic catgut for the peritoneum (L), interrupted sutures of 00 silk for the fascia (M), and 000 silk for the skin (N)

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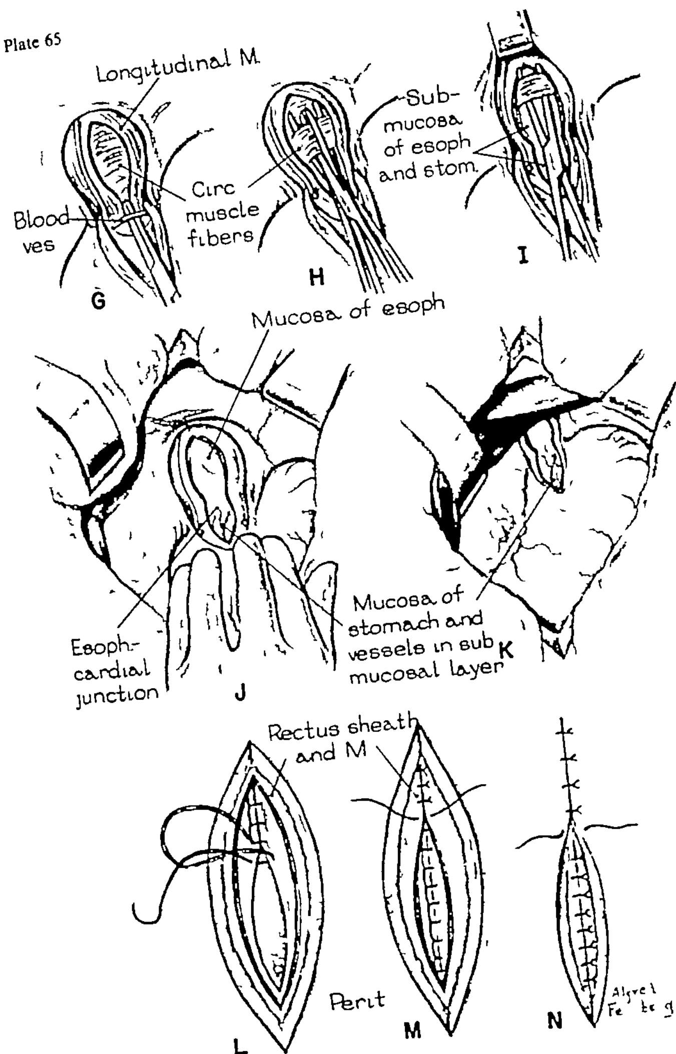
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Plate 65


Longitudinal M.
Blood ves
Circ muscle fibers
Sub-mucosa of esoph and stom.
G
H
I
Mucosa of esoph
Esoph-cardial junction
J
Mucosa of stomach and vessels in sub mucosal layer
K
Rectus sheath and M
Perit
L
M
N

G The incision through the longitudinal muscle layer of the esophagus is completed, and the underlying layer of circular muscle fibers is visible A vessel crossing transversely at the level of the cardia is shown elevated on a clamp prior to its double ligation and severance

H, I. Following the completion of the incision in the longitudinal muscle layers of the esophagus, the cardia, and the segment of the gastric wall immediately below the cardia, the underlying circular layers of muscle fibers are elevated in segments and severed by scissor dissection.

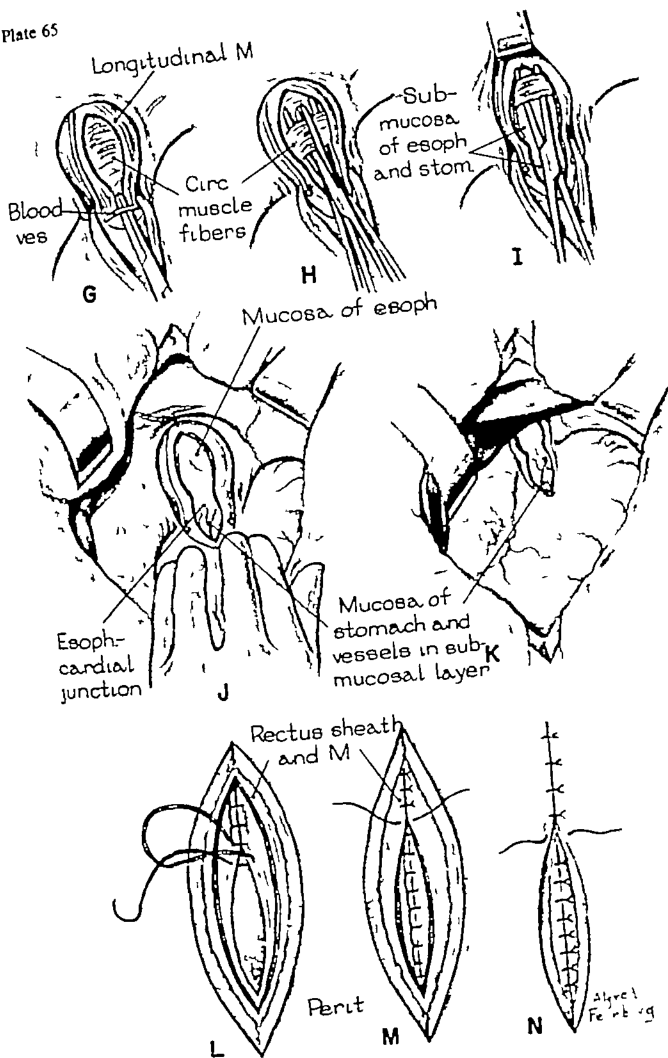
J K. The esophagocardiomyotomy is completed and the herniation of portions of the mucosa of the esophagus the cardia, and the adjacent segment of the stomach respectively are depicted The prominence of the vessels in the submucosal layer of the stomach may also be seen.

L, M N The wound is closed in layers using a double strand of a continuous interlocking suture of 00 chromic catgut for the peritoneum (L) interrupted sutures of 00 silk for the fascia (M), and 000 silk for the skin (N)

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Plate 65


Longitudinal M
Blood ves
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Sub-mucosa of esoph and stom
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Esoph-cardial junction
J
Mucosa of stomach and vessels in sub-mucosal layer
K
Rectus sheath and M
Perit
L
M
N

ESOPHAGECTOMY LEFT TRANSPLEURAL TRANSDIAPHRAGMATIC APPROACH WITH SUPRAAORTIC AND INFRAAORTIC ESOPHAGOGASTROSTOMY

A. The patient is placed in the direct right lateral prone position, and the left thoracotomy incision is shown in dotted outline. Although not shown, the seventh rib is partially resected and segments (2 cm.) of the vertebral ends of the sixth and eighth ribs are also removed. The related intercostal neurovascular muscle bundles are clamped, severed and ligated with suture ligatures of silk (00)

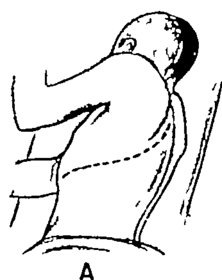
B. The left pleural cavity is entered, and the rib cage is separated over protective moist towels with a self retaining retractor (Finochietto) The incision in the posterior mediastinal pleura is depicted by the dotted line

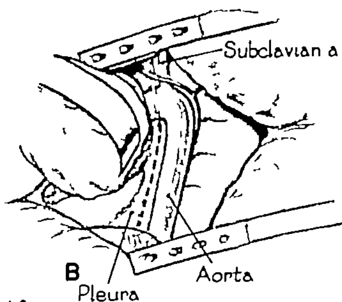
C. The cut margins of the mediastinal pleura are retracted with guy sutures (0000 silk) and the tumor of the esophagus is exposed. The lower portion of the esophagus, previously mobilized by blunt digital dissection is encircled by a cotton tape for traction. With traction maintained anteriorly and toward the midline, the esophageal branches of the thoracic aorta are isolated, doubly ligated in continuity and then severed between the ligatures. Usually two and at the most three arterial branches are ligated in the area between the arch of the aorta and the diaphragm.

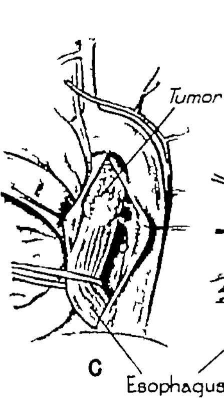
D, E. Dissection with scissors is continued in the fibroareolar tissue layer surrounding the tumor until it is completely mobilized from the surrounding structures. In the dissection at this level there is danger of injury to the azygos vein which is not visible and which may be adherent to the right side of the tumor bearing area of the esophagus.

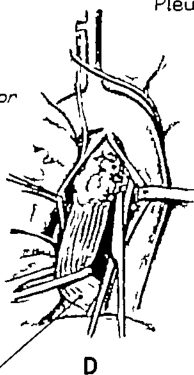
F The mediastinal pleura above the aortic arch and lateral to the subclavian artery is incised and the cut margins are secured with guy sutures of silk (0000)

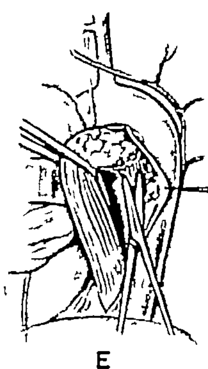
G G The supraaortic segment of the esophagus is encircled by a cotton tape and retracted in various planes as the surrounding fibroareolar tissue is severed (dotted lines) by scissor dissection. In performing the dissection in this area the surgeon should be cognizant of the proximity of the lymphatic duct and the increased likelihood of its injury



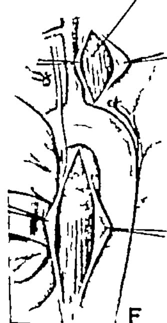


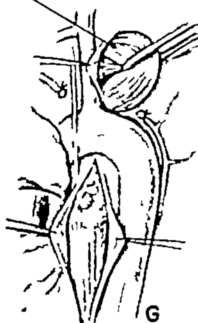


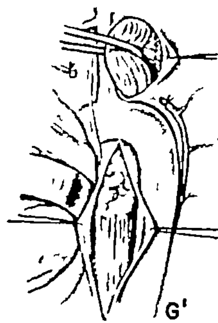




Esophagus







H. The supraaortic and infraaortic segments of the esophagus are encircled by cotton tapes through which traction is applied to elevate the esophagus and the tumor mass from the depths of the mediastinum. Traction guy sutures of silk (00) are used to tent a portion of the left leaflet of the diaphragm which is incised in the direction indicated by the dotted line. This radial incision extends through the esophageal hiatal ring preparatory to the mobilization of the esophagocardial junction.

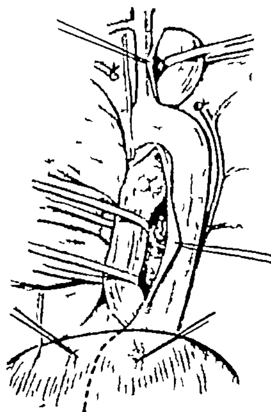
I. The transdiaphragmatic incision is completed and the subjacent intraperitoneal viscera are demonstrated. This incision converts the left pleural and the subjacent peritoneal cavity into one common cavity.

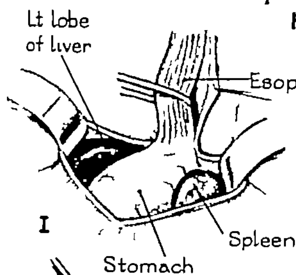
J. The anterior wall of the stomach is grasped in a Babcock clamp through which traction is applied to displace the stomach upward into the left pleural cavity. The severance of the gastrocolic ligament below the gastroepiploic arch is indicated in dotted outline.

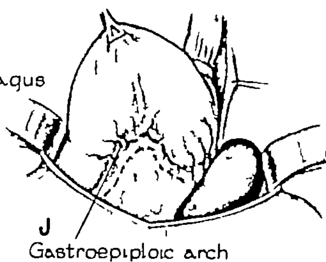
K. The mobilization of the greater curvature of the stomach is continued by doubly clamping and severing (dotted line) the gastrosplenic ligament and its contained vasa brevia.

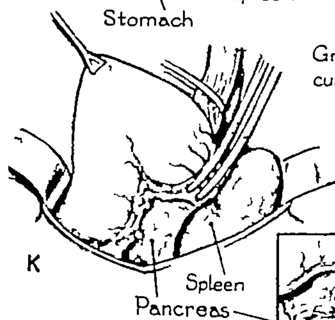
L. The completely mobilized greater curvature of the stomach is grasped in Babcock clamps and retracted anteriorly and cephalad to show the left gastric vessels, contained in the gastropancreatic fold of peritoneum, triply clamped prior to their severance between the two distal clamps.

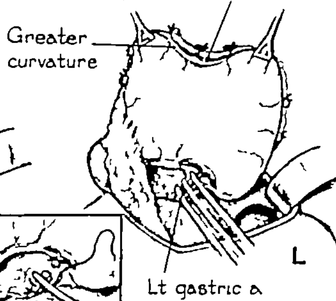
L. The clamped and severed left gastric vessels are occluded proximally with a ligature of silk (00) and the lowermost clamp is removed. A second suture, a suture ligature of 00 silk, is inserted distally beneath the uppermost clamp which is removed as the suture is tied.

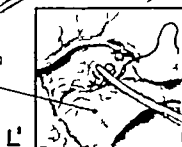

H


Lt lobe
of liver
Esophagus
I
Spleen
Stomach


J
Gastroepiploic arch


K
Spleen
Pancreas


Greater
curvature
Lt gastric a
L


L'

M. The completely mobilized stomach, anchored only by its esophageal and duodenal attachments, is secured proximally with Babcock clamps, and the line of transection of the stomach below the clamp-occluded esophagocardial junction is shown in dotted outline

N O The oblique *opening in the proximal* segment of the stomach is closed with interrupted sutures of silk (000). The sutures are inserted from the "inside out" and from the "outside in" so that when tied the knots are on the inside of the lumen. The reinforcing second layer of interrupted *horizontal seromuscular mattress sutures* (Cushing) are inserted to complete the closure of the transected stomach. The esophagogastric stump proximally (O) is covered by a piece of rubber dam and occluded with two ligatures of No 1 silk.

P Q The long strands of the proximal ligature which occludes the distal end of the esophagus are passed upward behind the aortic arch, and by traction through these strands from above and digital manipulation from below (P) the tumor mass and the distal segment of the esophagus are displaced upward behind the arch of the aorta to a position anterior to the aortic arch (Q)

R. Traction sutures (000 silk) are inserted in the fundus of the stomach, and, immediately subjacent, a horizontal incision is made through the seromuscular layer of the stomach at the site of election for anastomosis to the esophagus. The vessels in the submucosal layer are undersewn with hemostatic suture ligatures of silk (0000) The performance, at this time, of this particular step in technic obviates troublesome bleeding when the opening into the lumen of the stomach is subsequently made (R'). The excision of a circular area of stomach wall is neither practiced nor recommended. A careful mucosa to mucosa approximation is considered the best prophylaxis for stenosis at the stomal site.

R The first posterior layer of interrupted sutures *are being inserted*. On the esophageal side the sutures are inserted at right angles to the fibers of the longitudinal muscle layer to increase the holding power of the tissues. The dotted line on the posterior wall of the esophagus indicates its site of transection. The opening into the lumen of the stomach is being enlarged by scissor dissection between the two rows of the previously inserted hemostatic ligatures which have been tied and cut.

R R A second posterior layer of interrupted and untied mattress sutures of silk (000) is inserted (R") these, when tied (R'"), effect an inversion of the tissue layers into the lumen of the anastomosis. A third posterior layer of interrupted sutures (000 *silk) is inserted (R ') through the whole* thickness of the inverted layers of the stomach and the esophagus

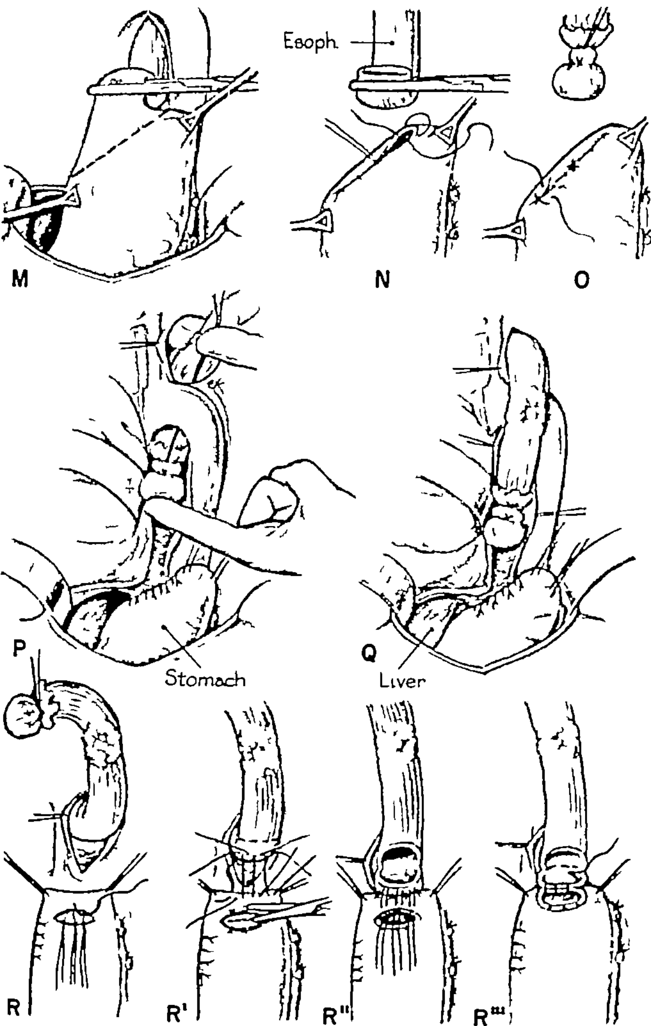
DISCUSSION—DR. JOHN H. GARLOCK For adequate exposure, I have found it necessary to remove only one rib usually the seventh, in most instances. By opening the rib spreader slowly and in stages, it is possible to obtain adequate room without cracking, accidentally or purposely the ribs above or below In heavy chested men, it may be necessary to divide the sixth or eighth ribs or both, and this is done without disturbing the intercostal neurovascular bundles

I would suggest using soft Penrose tubing instead of cotton tape when mobilizing the esophagus. Many patients with cancer of this organ exhibit friable musculature, and, unless the traction tape has considerable resiliency and "give," the organ may be torn at a site which is not to be excised. If the surgeon limits his dissection close to the esophagus in the supra-aortic area, he need have little fear of injuring the thoracic duct.

The use of grasping clamps, as depicted (Plate 67 K and L) is to be avoided for reasons stated previously The stomach can be easily and gently displaced above the opening in the diaphragm by the gloved hand.

When ligating the left gastric vessels, the surgeon should make every effort to clear this vascular pedicle of all lymph nodes. In more than 50 per cent of our cases, squamous cell cancers of the thoracic esophagus have metastasized retrogradely to the nodes along the left gastric artery

As stated before I would suggest a wider excision



Esoph.
M
N
O
P
Stomach
Q
Liver
R
R'
R''
R'''

S. The first anterior layer of the anastomosis is begun by inserting the angle sutures which are inserted from the "inside out" on one side and from the "outside in" on the other side, so that when tied the knots are on the inside of the lumen. Traction on the long strands of the angle sutures posteriorly facilitates the inversion of the first anterior layer

S The interrupted inversion sutures are inserted alternately from either end toward the center at which juncture the first two sutures are encircled by a figure of 8 mattress suture before being cut.

S The mattress suture is tied and cut and the second anterior layer of the anastomosis, a series of interrupted horizontal mattress sutures (Cushing) is begun.

T The *left supraaortic esophagogastrostomy* is completed. The intrathoracic portion of the stomach is anchored with interrupted silk (000) sutures to the mediastinal pleura, and the incision in the diaphragm is closed snugly about the transplanted stomach with interrupted silk (00) sutures.

U U Inset to show the extent of resection (U) and the completed infraaortic esophagogastrostomy (U′) for the surgical removal of a carcinoma in the region of the esophagocardial junction.

V V V Inset to show an alternate method, used in one patient in the treatment of a carcinoma of the midthoracic segment of the esophagus (V) The thoracic aorta is completely mobilized by ligation and severance of the paired intercostal arteries and rotated anteriorly (V′) This permits the transplantation of the mobilized stomach into the esophageal bed within the mediastinum and the establishment of the esophagogastric anastomosis posterior and superior rather than anterior and superior to the arch of the aorta (V V″)

W A Foley catheter (18 F) is partially withdrawn through a stab wound drainage site in the eighth intercostal space and connected to a water seal drainage bottle Periosteal windows" are made in the eighth rib and two pericostal sutures of double strands of No 2 chromatic catgut are inserted to encircle the eighth and sixth ribs When tied these sutures will approximate the rib cage about the partially resected seventh rib The partially resected segments (2 cm.) at the vertebral ends of the sixth and eighth ribs are also visible. The formation of periosteal "windows" is believed to lessen the incidence of post thoracotomy pain.

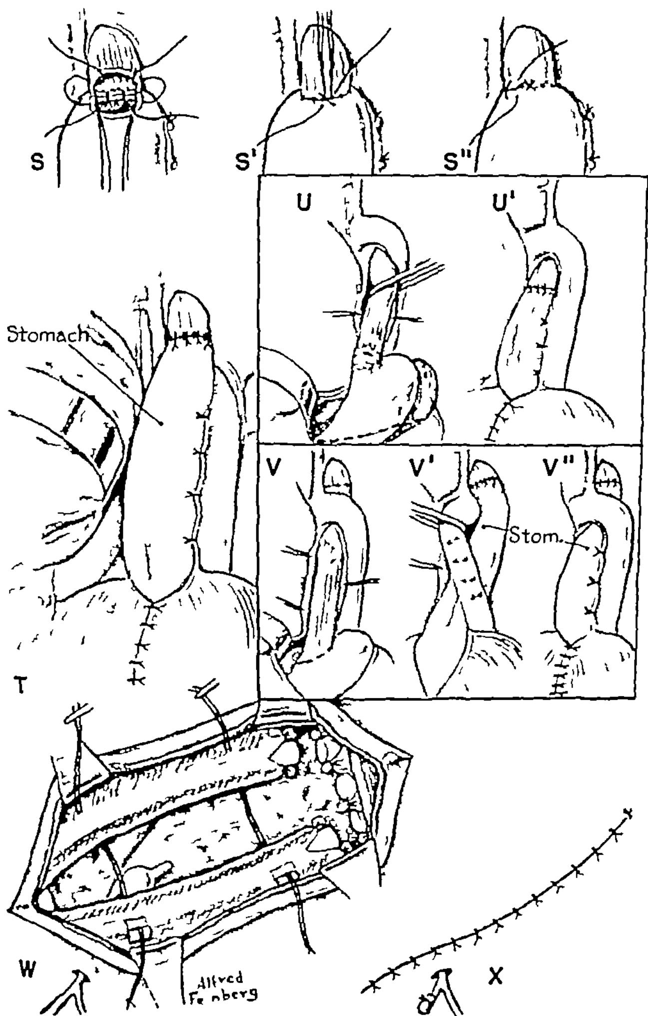
X. The completed closure of the skin incision with interrupted silk (000) sutures and the relation of the water-seal drainage catheter to the anterior rather than the middle or posterior portions of the incision is depicted.

DISCUSSION—DR GARLOCK (cont.)

of the beginning of the greater curvature of the stomach than is depicted in Plate 68, M The step of mobilization of the duodenum is always carried out in left sided esophagectomy for the reasons previously stated

I believe there is an easier method of making the anastomosis in the supraaortic area than that depicted in Plate 68, R, R R R‴ Before placing the first posterior row of sutures, a button of stomach wall is excised from the upper anterior wall of the stomach All vessels are carefully ligated with very fine silk After aspiration of stomach contents (blood and mucus), the opening is approximated to the esophagus at a site proximal to the area of subsequent transection. The first posterior layer of sutures is now placed in a dry field, the esophagus is transected and the anastomosis is completed. Trying to ligate vessels in the stomach wall at the site of anastomosis while the stomach is located high in the chest greatly complicates the details of an already difficult procedure.

Finally I have abandoned the operation of infraaortic anastomosis for squamous cell tumors of the distal esophagus because it is important to excise as much esophagus as possible proximal to the growth in order to get well beyond the submucosal spread so frequently seen in this location.


S
S'
S''
U
U'
Stomach
V
V'
V''
Stom.
T
W
X
Alfred Feinberg

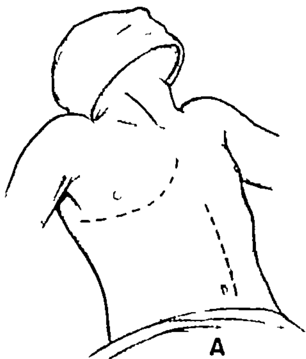
ESOPHAGECTOMY COMBINED RIGHT CERVICAL, RIGHT THORACIC, AND LEFT ABDOMINAL APPROACH WITH CERVICAL ESOPHAGOGASTROSTOMY

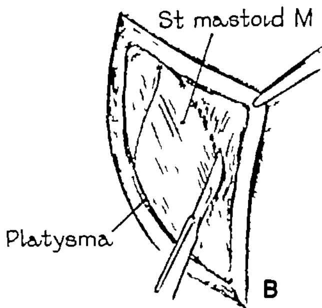
A. The patient is placed in the supine position and the head is rotated to the left. The cervical incision, the first to be made, is demonstrated by the solid line. The right anterior thoracotomy and the left upper paramedian abdominal incisions, which are made in the order mentioned, are indicated in dotted outline.

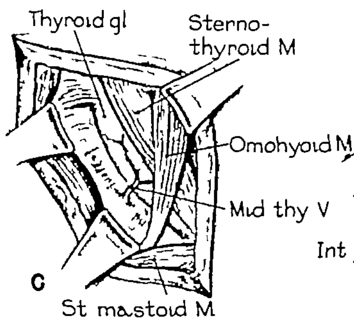
B. The cervical incision is deepened through the subcutaneous fatty tissue and the platysma muscle layers to expose the sternomastoid muscle, the anterior border of which is being mobilized by scalpel dissection.

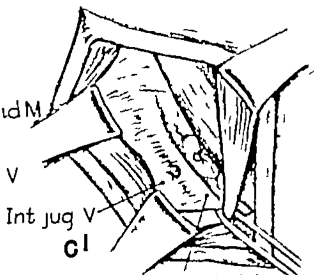
C. The mobilized anterior border of the sternomastoid muscle is retracted posteriorly and the underlying anatomic structures are exposed.

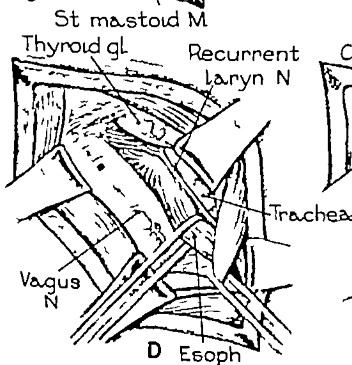
C^1 D D^1 The middle thyroid vein is firstly doubly ligated (000 silk) in continuity and then severed between the ligatures (C^1). This permits retraction of the right lobe of the thyroid gland anteriorly toward the midline and exposure of portions of the recurrent laryngeal nerve, the trachea and the esophagus (D). The cervical portion of the esophagus, mobilized by finger dissection, is encircled by a traction tape of rubber tissue. The left index finger of the surgeon is inserted along the outside of the esophagus into the superior mediastinum and the tumor, located in this segment of the esophagus, is palpated (D^1). The use of this maneuver at this time may frequently indicate whether or not the lesion is locally resectable and thereby avoid the necessity of making either a thoracotomy or abdominal incision.

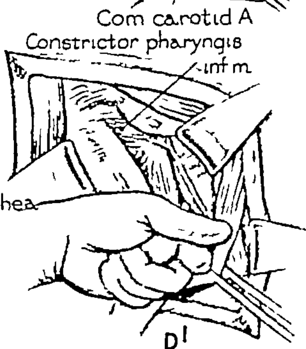



St mastoid M
Platysma
B


Thyroid gl
Sterno-
thyroid M
Omohyoid M
Mid thy V
C
St mastoid M


Int jug V
C1
Com carotid A


Thyroid gl
Recurrent
laryn N
Trachea
Vagus
N
D
Esoph


Constrictor pharyngis
inf m
D1

E. The cervical mediastinotomy and the digital exploration of the superior mediastinum is completed. The second incision to be made a right anterolateral thoracic incision, is indicated in dotted outline.

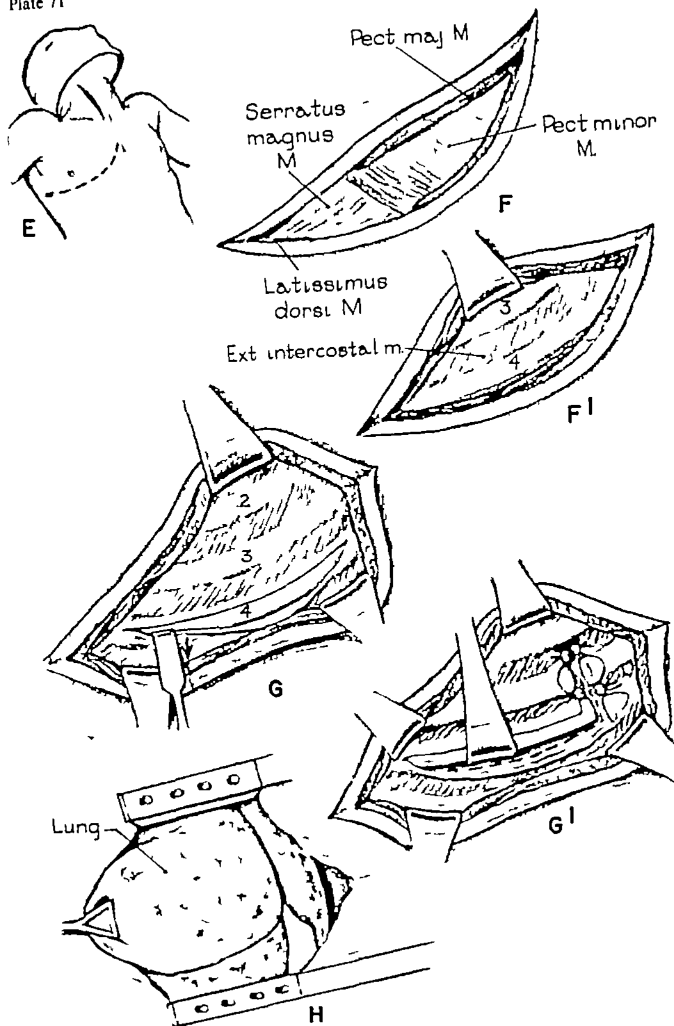
F F[1] The incision is deepened through the underlying pectoralis major and the latissimus dorsi muscles the superficial muscle layers (F), and then through the pectoralis minor and serratus anterior (magnus) muscles, the deep muscle layers, to expose the rib cage and one of the related intercostal muscle layers (F[1])

G The wound margins are retracted and portions of the second, third, and fourth ribs are exposed. An incision is made in the periosteum throughout the length of the exposed portion of the fourth rib and with a periosteal elevator the periosteum is removed from the lower half of the rib

G[1] The dissection of the periosteum from the fourth rib posteriorly is completed, and, by blunt digital dissection, a plane of cleavage is obtained between the endothoracic fascia and the posterior aspects of the second and third ribs respectively after the manner of Sir R. C. Brock. The adjacent intercostal muscle bundles are doubly clamped, severed, and ligated with suture ligatures of 000 silk The incision in the endothoracic fascia and the parietal pleura behind the fourth rib is shown in dotted outline

H. The right pleural cavity is entered and the wound margins are retracted over protective moist towels with a self retaining retractor (Finochietto) to expose portions of the lobes of the lung.

Plate 71

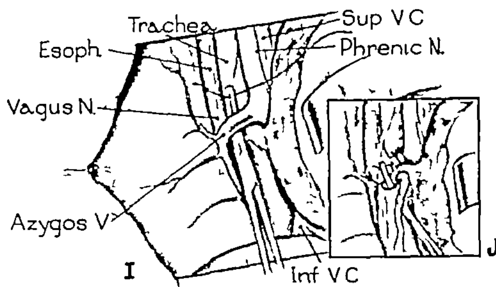

Pect maj M
Serratus magnus M
Pect minor M.
F
E
Latissimus dorsi M
3
Ext intercostal m.
4
F1
2
3
4
G
G1
Lung
H

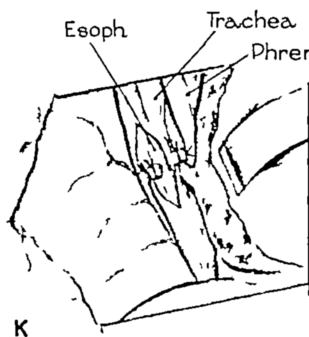
I J The right lung is retracted anteriorly and toward the midline to expose the related structures posteriorly The azygos vein is mobilized on a curved clamp preparatory to withdrawing the first of two silk (00) ligatures for ligation of the vein in continuity (I) Subsequently the azygos vein is doubly clamped between the two ligatures and severed. Each clamp is then replaced by a suture ligature of 00 silk (J)

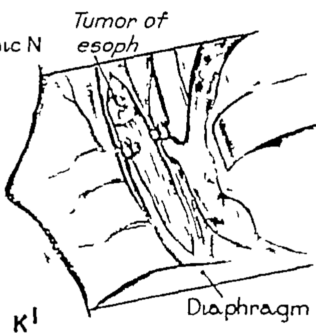
K, K[1] The severance and ligation of the azygos vein is completed (K) and the mediastinal pleura is incised to expose the thoracic segment of the esophagus and the tumor located in its proximal portion above the aortic arch (K).

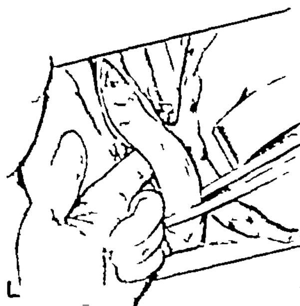
L The caudad end of the thoracic esophagus is encircled by a cotton tape for traction as mobilization of the esophagus is continued by blunt digital dissection.

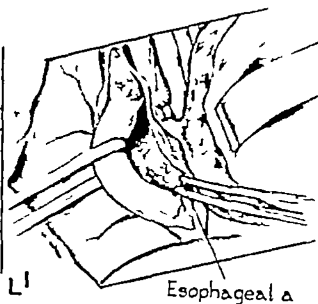
L[1] The partially mobilized thoracic esophagus is retracted laterally and posteriorly and the second of two of the esophageal arterial branches from the thoracic aorta is doubly clamped prior to its severance One of the ligated stumps of the esophageal artery previously ligated and severed is also visible.


Trachea
Sup V C
Esoph
Phrenic N.
Vagus N.
Azygos V
I
J
Inf V C


Esoph
Trachea
Phrenic N
K


Tumor of
esoph
Diaphragm
K¹


L


L¹
Esophageal a

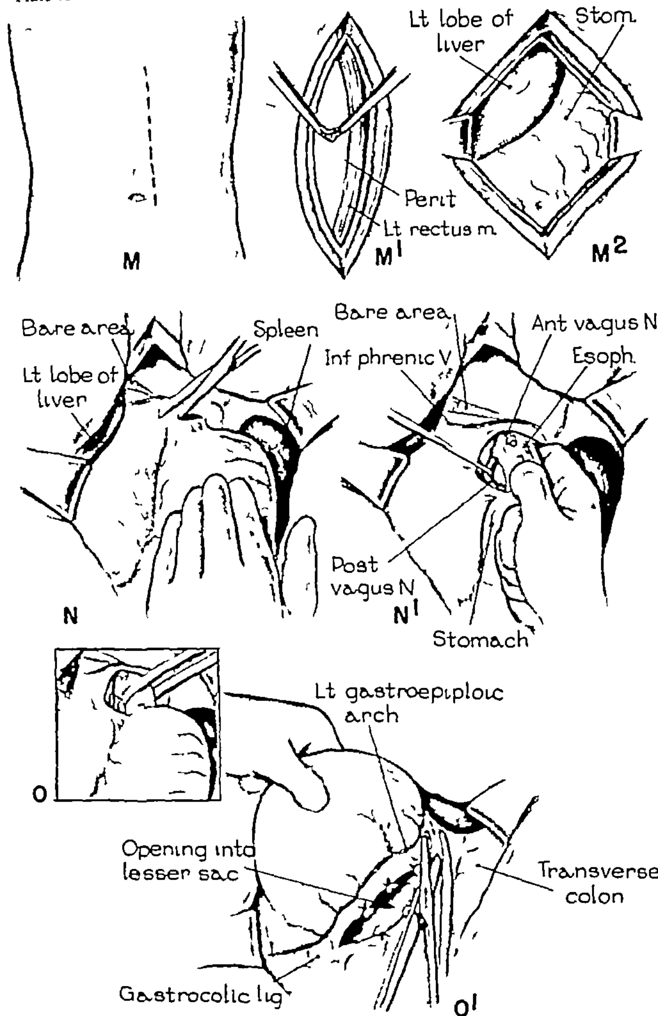
M M[1] M The third incision an upper left paramedian muscle-retracting (lateral) abdominal incision is depicted in dotted out line (M). This incision is deepened through the anterior rectus sheath, and the under lying left rectus muscle is mobilized from its midline attachment (M) An incision is made in the posterior rectus sheath and anterior parietal peritoneum, and the incised margins are grasped in clamps (M) pre paratory to extension of the incision both cephalad and caudad to expose the under lying intraperitoneal viscera (M²)

N The left lobe of the liver mobilized by severance of the avascular left triangular liga ment, is turned downward on itself and re tracted toward the midline. By manual traction the stomach is displaced downward, and by scissor dissection an opening is made through the musculofascial fibers of the diaphragm overlying the lower end of the esophagus immediately cephalad to the esophagocardial junction.

N[1] By digital dissection within the posterior mediastinum the lower end of the esopha gus is mobilized on the index finger The anterior (left) vagus nerve is severed and a silver brain (Cushing) clip is applied to its proximal cut end. The posterior (right) vagus nerve is mobilized on a nerve hook prior to its severance. The transection of the vagus nerves is a technical aid in the freeing of the esophagus from its surrounding attachments.

O O[1] The completely freed lower end of the esophagus is encircled by a tape of rubber tissue for both future identification and traction (O) Mobilization of the greater curvature of the stomach below the gastroepiploic arch is begun by serially clamping and severing the gastrocolic ligament (O). The maintenance of continuity of the gastroepiploic arch is important in assuring an adequate blood supply to the stomach when its mobilization is completed

Plate 73


M
Lt lobe of liver
Stom
Perit
Lt rectus m
M1
M2
Bare area
Spleen
Lt lobe of liver
N
Bare area
Inf phrenic V
Ant vagus N
Esoph
Post vagus N
N1
Stomach
Lt gastroepiploic arch
O
Opening into lesser sac
Transverse colon
Gastrocolic lig
O1

P Mobilization of the greater curvature and fundus of the stomach is continued by serially clamping and severing the gastrosplenic ligament and its contained vasa brevia.

Q Upon completion of the mobilization of the fundus of the greater curvature of the stomach, an incision, indicated by the dotted line is made in the posterior parietal peritoneum lateral and inferior to the descending (second part) and horizontal (third part) portions of the duodenum before freeing it by blunt digital dissection posteriorly

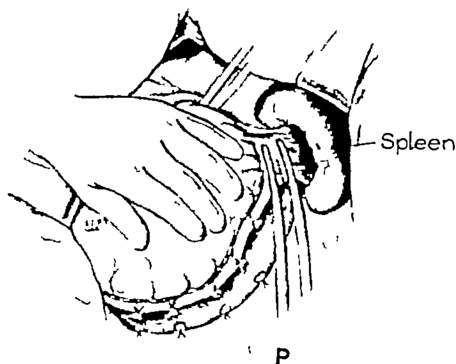
Q[1] The duodenal loop and the head of the pancreas are mobilized by blunt digital dissection in the relatively avascular areolar tissue plane posteriorly and the related anatomic structures are depicted. The dissection of the horizontal portion of the duodenum is continued medially until the superior mesenteric vascular stalk and the uncinate process of the pancreas are identified In this dissection caution must be observed to avoid making a rent in the base of the mesentery of the colon through which the small bowel may herniate

Q[2] The finger of the right hand of the surgeon is inserted behind the mobilized greater curvature of the stomach and after transgressing the lesser sac an opening is made in the velumous gastrohepatic ligament from behind by blunt digital dissection. The transection of this ligament to mobilize the whole of the lesser curvature of the stomach is indicated by the dotted line. The continuity of the right gastric artery on the lesser curvature similar to the continuity of the right gastroepiploic artery on the greater curvature is preserved

Discussion—Dr John H Garlock It has been and still is my practice to use the right sided approach for cancers of the esophagus located behind the aortic arch or more proximally up to the general level of the suprasternal notch The technic of Ivor Lewis requiring three separate incisions as depicted in A, Plate 70 has been replaced by a right thoracoabdominal incision, traversing the sixth or seventh interspace with division of the cartilaginous costal arch and extension downward along the upper midabdomen. Of course the final esophagogastric anastomosis in the neck requires a cervical incision either on the right or left side depending on how easily the cervical esophagus swings to one or the other side. To accomplish this operative approach, the thoracic portion of the operation can be more expeditiously carried out if the patient is tilted forward about 45 degrees When mobilization of the stomach becomes indicated, the table may be tilted backwards so that the patient assumes the straight supine position This makes it much easier to separate the stomach from its vascular attachments and permits the surgeon to handle the stomach with a minimum of trauma, an important feature in the prevention of thrombosis in the stomach wall. The cervical incision is, therefore the last one made, after it has been determined that one is dealing with a resectable tumor It is usually not possible to determine operability of an esophageal cancer located in the superior mediastinum by finger exploration through the cervical incision.

With the use of the thoracoabdominal incision, it is unnecessary to remove ribs, thereby eliminating all possibility of subsequent intercostal neuralgia, a disabling aftermath which frequently follows the maneuvers depicted (Plate 71 E through H).

Dissection of the esophagus from the mediastinum should include all removable areolar tissue and careful ligation of the segmental esophageal arteries arising from the descending aorta Fatal postoperative



Q

Rt gastro-epiploic A
Pancreas
Trans mesocolon
Gastroduod. A
Sup pancreaticoduodenal A
Q1

Gastro-hepatic lig
Rt. gastric a
Duod
Q2

Q3 The mobilized greater curvature of the stomach is rotated anteriorly and retracted cephalad to demonstrate the left gastric vessels contained within the gastropancreatic fold of peritoneum, triply clamped prior to severance between the two distal clamps.

Q4 The stomach is replaced in its normal position and the remaining intact segment of the gastrohepatic ligament is serially clamped and severed as indicated.

R. The mobilization of the lesser and the greater curvatures of the stomach is completed and the lower portion of the esophagus and proximal portion of the stomach are retracted to expose the hiatal ring which is formed by the separation of the muscle fibers of the right crus into superficial and deep muscle layers

R1 The cardioesophageal region, encircled by a cotton tape for traction, is displaced downward and laterally to demonstrate the transection of the superficial layer of muscle fibers of the right crus which forms the right margin of the hiatal ring. This maneuver enlarges the hiatal ring and facilitates the transplantation of the mobilized stomach from the peritoneal cavity into the right pleural cavity

S. By manual manipulation from below and upward traction from within the thoracic incision above the stomach is displaced through the enlarged esophageal hiatus into the right pleural cavity

S1 The transplantation of all but the distal segment of the pyloric portion of the stomach into the right pleural cavity is completed, and the change in position of the related viscera within the peritoneal cavity is illustrated

Discussion Dr Garlock (cont.)

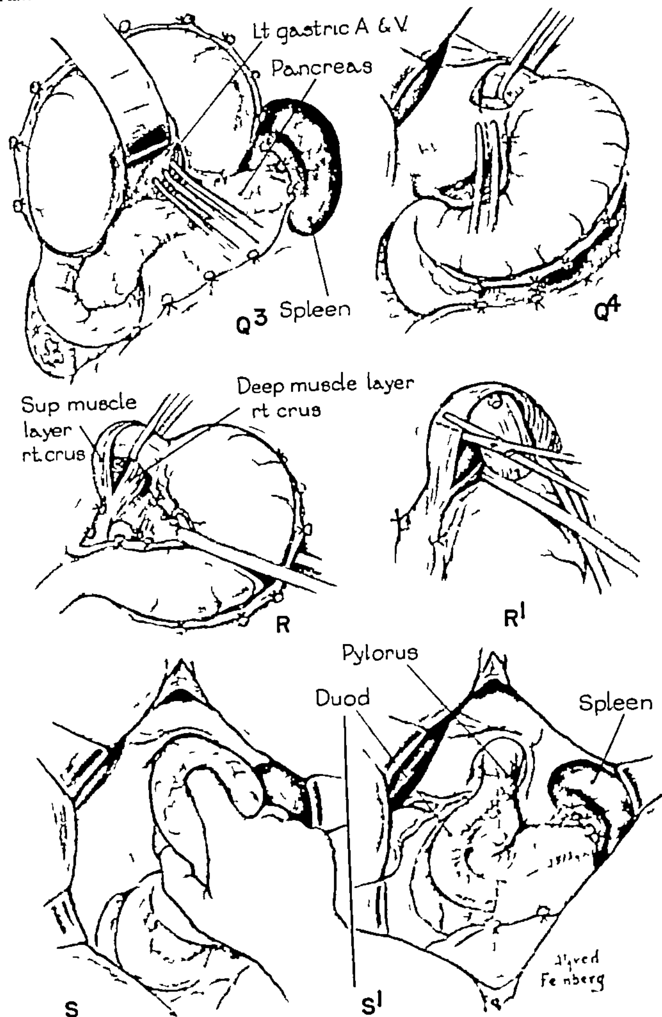
hemorrhage has been known to occur from one of these vessels ligated too close to the aorta

The importance of gentle handling of the stomach through all phases of its mobilization and subsequent transplantation in the chest cannot be overemphasized There is every reason to believe that local trauma may produce thrombosis and localized necrosis with perforation in the early postoperative period Another important feature in the adequate mobilization, depicted in Plate 74, Q and Q is concerned with the freeing of the second and third parts of the duodenum This maneuver prevents axial rotation of the duodenum when the stomach is transplanted into the chest and also provides increased length to the stomach in its new position

In Plate 76 T the line of transection of the stomach is indicated by a dotted line. I would suggest removal of at least two more inches of the beginning of the greater curvature so that the line of transection is more oblique than depicted. The reason for this is that the most precarious area from the standpoint of adequate blood supply is located here Almost all postoperative leakages have occurred in this region. This usually fatal complication has been obviated in recent years by removal of the potentially dangerous area

The importance of not inserting too many sutures at the anastomosis is clearly shown in V through V Plate 77 Oversuturing this area may lead to obliteration of the tenuous blood supply of the esophageal stump which receives its nourishment here from small branches of the inferior thyroid arteries.

Plate 75



Lt gastric A & V
Pancreas
Spleen
Q3
Q4
Deep muscle layer
rt crus
Sup muscle
layer
rt. crus
R
R1
Pylorus
Duod
Spleen
S
S1
Alfred
Feinberg

T T[1] The completion of the transplantation of the stomach into the right pleural cavity is shown. The lower end of the esophagus is occluded by a clamp preparatory to the resection of a subjacent segment of the stomach which is indicated by the dotted line Accordingly resection of the whole of the caudad portion of the esophagus is assured The transected esophagogastric stump is occluded with a piece of rubber dam and the opening in the gastric lumen is closed in two layers using interrupted sutures of 000 silk (T[1]).

Esophagectomy—Combined Approach

U U[1] By a combination of digital traction through the cervical incision and manual manipulation from within the thoracic incision (U), the mobilized thoracic and abdominal segments of the esophagus are displaced upward into and out through the right cervical incision (U[1]). In like manner the fundus of the transplanted stomach, secured by traction guy sutures of silk (00), is mobilized into the cervical mediastinum (U).

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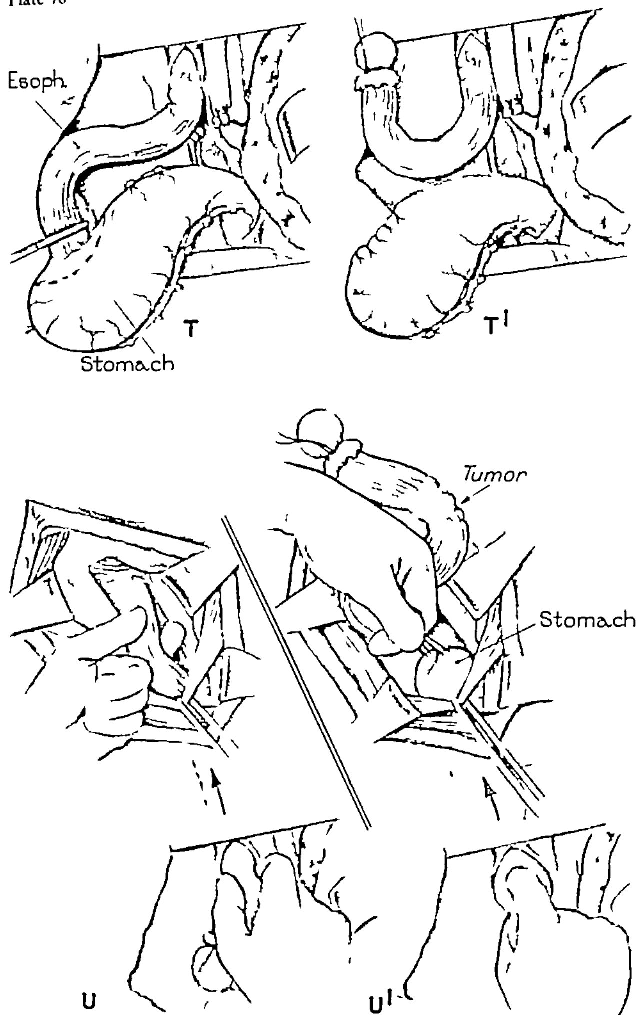
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Plate 76



V For technical expediency an opening is made in the fundic portion of the stomach before the insertion of the interrupted silk sutures (000) which form the first posterior layer of the esophagogastric anastomosis To increase the holding power of the tissues of the esophagus these sutures are inserted in the wall of the esophagus at right angles to its longitudinal layer of muscle fibers.

V1 The first posterior layer of sutures is tied to approximate the posterior wall of the stomach and the fundus of the esophagus. Two of the series of through and through interrupted sutures which will comprise the second posterior layer are inserted at either angle of the anastomosis but are not tied.

V2 The insertion of the second layer of sutures posteriorly is completed and the transection of the esophagus anteriorly is being completed by scissor dissection.

V3 The first anterior layer of the anastomosis consists of a series of interrupted silk (000) sutures which are inserted from the "inside out" to the "outside in" so that, when tied, the knots are on the inside of the lumen. The first angle suture anteriorly is inserted but not tied. Traction in the long axis of the anastomosis is applied to the strands of the angle suture posteriorly as the anterior angle suture is tied. This facilitates the inversion of the first layer of the anastomosis anteriorly

V4 V5 V6 V7 The interrupted sutures are inserted alternately from either end toward the center (V) where the first layer anteriorly terminates (V) The site of termination of these sutures is encircled by a figure of 8 mattress suture (V) which, when tied (V⁶), lessens the likelihood of an anastomotic leakage For the second layer anteriorly a series of interrupted mattress sutures (000 silk) is used (V) These sutures are inserted at right angles to the layer of longitudinal muscle fibers of the esophagus (V⁶) and when tied (V⁷) a telescoping of the esophagus into the serosal lined wall of the stomach is effected

W This is a view through the cervical incision showing the completed esophagogastrostomy and its relation to the surrounding structures.

X. This is a view from within the right pleural cavity showing the right lung retracted anteriorly toward the midline and the transplanted stomach attached to the cut margins of the mediastinal pleura with a series of interrupted silk (000) sutures.

Y The operation is completed and the cervical, thoracic, and abdominal incisions are closed. The relation of the transplanted stomach to these incisions is depicted in transparent outline.

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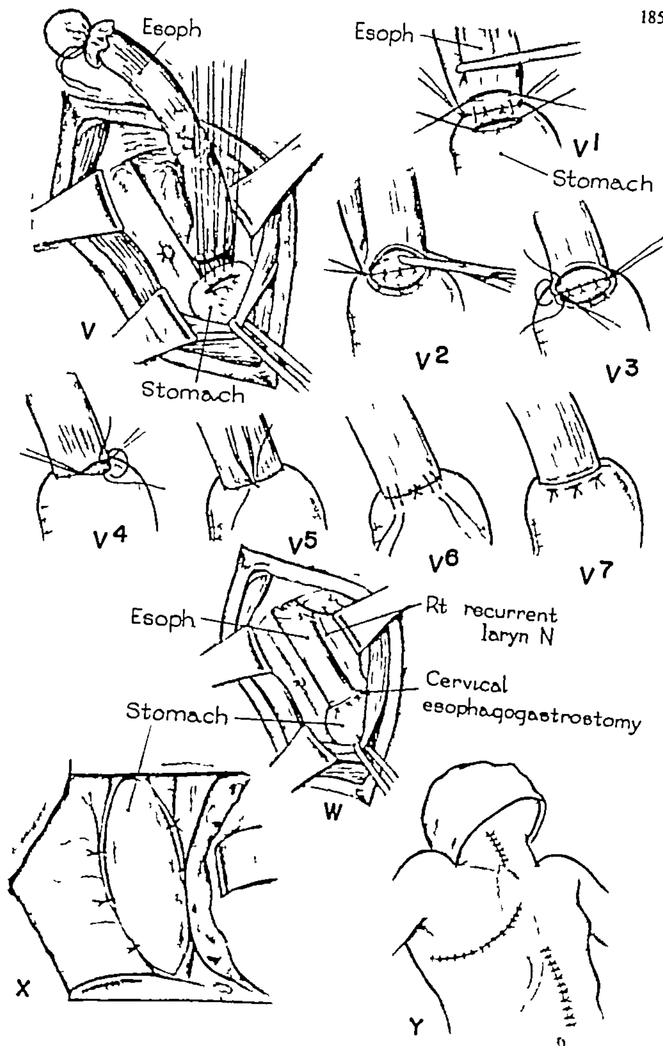
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Esoph
Stomach
V
Esoph
Stomach
V1
V2
V3
V4
V5
V6
V7
Esoph
Rt recurrent laryn N
Cervical esophagogastrostomy
Stomach
W
X
Y

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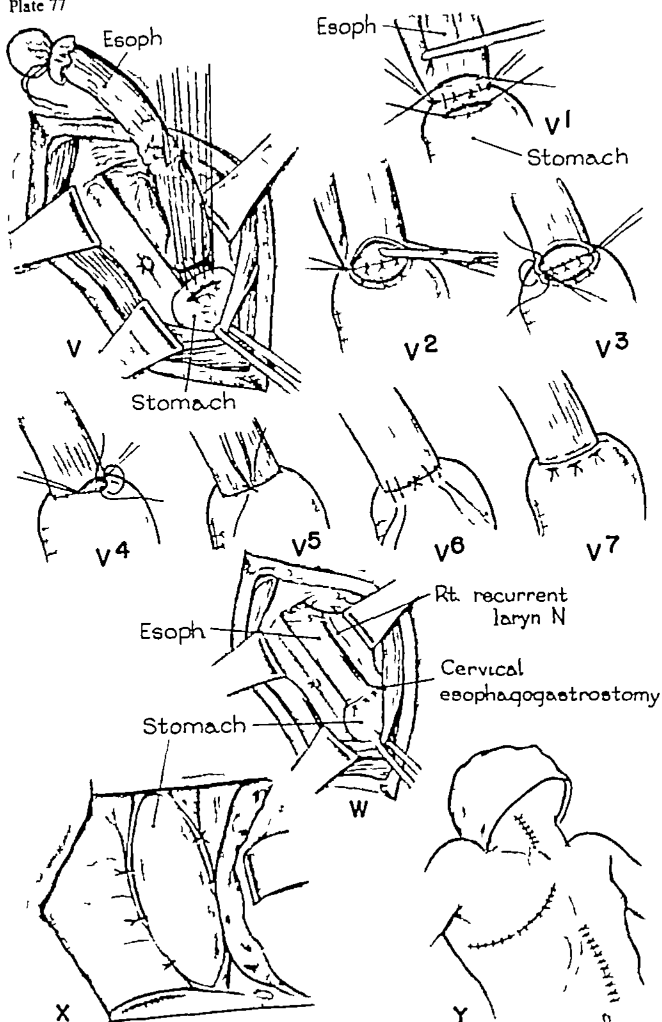
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Plate 77


Esoph
Stomach
V
Esoph
V1
Stomach
V2
V3
V4
V5
V6
V7
Rt. recurrent
laryn N
Esoph
Cervical
esophagogastrostomy
Stomach
W
X
Y

THE TRANSTHORACIC APPROACH FOR THE REPAIR OF AN ESOPHAGEAL HIATUS HERNIA

TOP

Artist's illustrations of the inferior or abdominal aspect of the diaphragm drawn from a fresh cadaver specimen. The right crus, longer, thicker, and more tendinous than the left, separates into superficial and deep muscle bundles to form completely the esophageal hiatus. The superficial layer forms the right margin and the deep layer the left margin of the hiatal ring, effecting a slinglike arrangement of the fibers of the right crus. The close relation of the tendinous portion of the diaphragm and the inferior phrenic vein to the anterior angle of the hiatal ring is depicted.

MIDDLE

A. Artist's interpretation of the anatomy of the esophageal hiatus drawn from a fresh cadaver specimen showing the esophageal hiatus from the abdominal view. The formation of the hiatal ring or sling by the muscle fibers of the right crus is depicted. The greater length and width of the right crus compared to the left are demonstrated.

B. The esophageal hiatus as it appears looking obliquely downward from the head of the cadaver specimen. The thick or deep layer of muscle fibers of the right crus which forms the left margin of the hiatal ring lies superficial to and crosses the superficial or thin layer of muscle fibers of the right crus which forms the right margin of the hiatal ring.

C. Diagrammatic representation of the sling-like arrangement of the muscle fibers of the right crus of the diaphragm in the formation of the esophageal hiatal ring.

BOTTOM

These two artist's illustrations were drawn from fresh cadaver specimens and show the variations in the anatomy of the esophageal hiatus from that previously described.

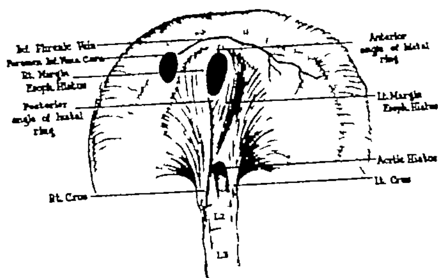
Left. The muscle fibers of the left crus are separated into superficial and deep layers. The fibers of the superficial layer cross over the deep layer of muscle fibers of the right crus, and join with the fibers of the superficial layer of the right crus to form the right margin of the esophageal hiatal ring.

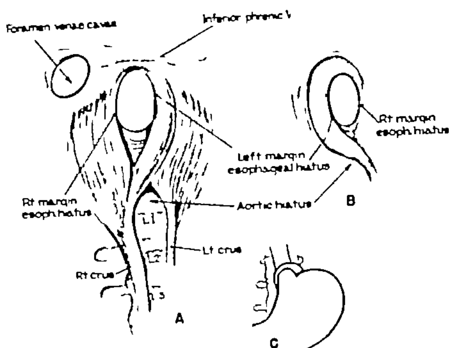
Right. In this specimen a thick bundle of muscle fibers from the left crus crosses beneath the deep layer of fibers of the right crus and ultimately blends with the superior or thoracic surface of the superficial layer of muscle fibers of the right crus. This particular anatomic configuration was originally described by Low and the crossing bundle of fibers of the left crus is commonly called *the band of Low*.

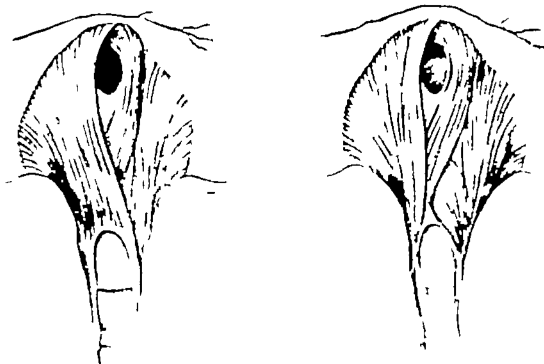
DISCUSSION—DR. RICHARD H. SWEET. A knowledge of the anatomy of the diaphragm and particularly of the structures in and about the esophageal hiatus is essential to an understanding of the principles involved in the successful repair of a hiatus hernia. Plate 78 (Top) shows the configuration of the muscle bundles of the right crus and the relations of the right and left crura. It should be emphasized, however, that this is a view of the inferior surface of the diaphragm. When viewed from above on the mediastinal surface, the right margin of the hiatus becomes the deep layer and the left margin is the superficial layer. This distinction is important for those who use the thoracic approach. The view in Plate 78, Top, is that of the surgeon who uses the abdominal approach. This is true also of Plate 78, Middle, A. Plate 78, Middle, B shows the relations of these bundles as seen when the thoracic approach, which is preferred, is employed.

These relations of the muscle fibers which constitute the margin of the hiatus are of interest to the surgeon, but of even greater importance is an understanding of the disposition of the fascial layers and of the peritoneum in both the normal condition and in the presence of an esophageal hiatus hernia. One must realize that the pouch of peritoneum which comprises the hernial sac in the sliding variety in hernia pushes up in front of and to the right of the anterior surface of the herniated portion of stomach. Because of its anatomic relations it is impossible for the sac to envelop the entire circumference of the stomach, the anterior wall of which always makes up the posterior wall of the sac. Thus the term "sliding type" is the technically correct designation for this kind of herniation.

Plate 78


Inf. Phrenic Vein
Foramen Inf. Vena Cava
Rt. Margin Esoph. Hiatus
Posterior angle of hiatal ring
Rt. Crus
Anterior angle of hiatal ring
Lt. Margin Esoph. Hiatus
Aortic Hiatus
Lt. Crus
L2
L3


Foramen venae cavae
Inferior phrenic V
Left margin esophageal hiatus
Rt margin esoph. hiatus
Aortic hiatus
Rt margin esoph. hiatus
L1
Lt crus
Rt crus
A
B
C



A. The patient is placed in the right lateral prone position, and the incision overlying the eighth interspace is outlined.

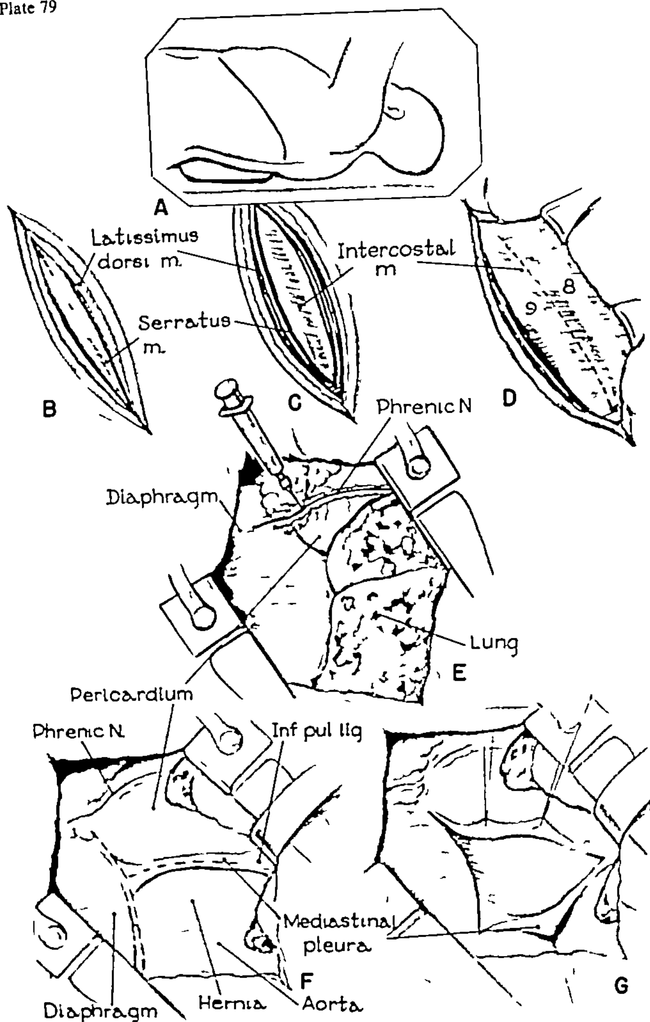
B C, D The incision is deepened through the underlying muscle layers to expose the line of incision in the eighth interspace

E. The left pleural cavity is entered, and the wound margins are retracted with two self retaining rib retractors of the Tuffier type. The resection of a rib is not required. The phrenic nerve is not crushed by clamping, but temporary paralysis of the diaphragm is obtained by injection of the nerve with 6 to 8 ml. of procaine solution (one per cent). Paralysis of the phrenic nerve by crushing destroys the bellowslike action of the diaphragm which is believed to predispose to postoperative pulmonary complications.

F The deflated left lung is displaced upward and maintained in position by retraction over a moist gauze pad This exposes the characteristic protrusion of the sliding hernia in the esophageal triangle. This triangle is bounded medially (anteriorly) by the pericardium and laterally (posteriorly) by the aorta. The base is formed by the diaphragm and the apex by the proximal portion of the inferior pulmonary ligament. The inverted T shaped incision in the mediastinal and diaphragmatic pleura is depicted by the dotted lines The horizontal portion of this incision extends medially (anteriorly) to the base of the pericardium and laterally (posteriorly) to a point just beyond the thoracic aorta.

G The flaps of mediastinal pleura are retracted by guy sutures of silk (000) and the extension of the underlying muscle fibers of the diaphragm onto the base of the hernial protrusion may be seen.

Plate 79


A
Latissimus dorsi m.
Intercostal m
Serratus m.
8
9
B
C
D
Phrenic N
Diaphragm
Lung
E
Pericardium
Phrenic N.
Inf pul lig
Mediastinal pleura
F
G
Diaphragm
Hernia
Aorta

H, I The distal portion of the esophagus is first mobilized by blunt digital dissection and then encircled by a rubber tissue drain. Traction upward on the esophagus is maintained and the hernia is mobilized by scissor dissection to expose the whole of the hiatal muscle ring which is formed completely by the muscle fibers of the right crus of the diaphragm (I) This step is considered an essential part of the operative technic The thick layer of muscle fibers of the right crus which forms the left margin of the esophageal hiatal ring is anterior (lateral) and crosses superficial to the thin layer of muscle fibers of the right crus which is posterior (medial) and which forms the right margin of the esophageal hiatal ring.

J A segment of the diaphragm in juxtaposition to the esophageal hiatus is tented by Babcock clamps and incised as indicated by the dotted line

K. The left index finger of the surgeon is inserted through the incision in the diaphragm into the peritoneal cavity and then upward through the esophageal hiatus into the hernial sac The overlying structures are tented on the index finger and the phrenoesophageal ligament is incised to expose the underlying layer of the parietal peritoneum which forms the anterior wall of the sliding hernial sac. The area of the phrenoesophageal ligament to be excised is depicted in dotted outline This ligament is a definite anatomic structure, possessed of good holding power and best demonstrated by elevation on the index finger as indicated

L, M. Similarly as in K, the peritoneum is incised and the lumen of the hernial sac is entered. This exposes the posterior wall of the hernial protrusion which is formed by the anterior wall of the stomach and thereby conforming to the definition of a sliding hernia. A sliding hernia defined is an irreducible hernia in which a portion of the wall of the sac is formed by the protruding or herniated viscus.

DISCUSSION—DR. SWEET (cont.)

The fascial layer called by Allison the "phrenoesophageal ligament" is often so stretched out over the herniated stomach and the sac that it may not be recognized unless the surgeon realizes that this layer is always present. It is made up of a reflection of the transversalis fascia below and of the mediastinal fascia above which fuse at the margins of the hiatus to provide a loose tissue attachment for the esophagus. It is difficult to demonstrate this layer in a drawing, but it is important to place sutures in it at the operation. An impression of the relations of this layer may be gained from Plate 80 K, L, and M

The impression is gained from Plates 80 and 81 that the cardia must always be pulled down below the hiatus by means of a sling inserted through a counter incision in the diaphragm. Although this maneuver is helpful, it is by no means always necessary Actually the majority of hernias, excepting those which are unusually large or when the patient is excessively fat, can be handled without openin t e diaphragm This is done either by plication of the sac when it is small or by incision of the sac in the larger hernias. In the latter additional sutures placed in the fascial layer are often needed to maintain a complete reduction of the hernia.

Plates 80 and 81 demonstrate clearly all of the steps in the repair of the hernia. The placing of sutures across the hiatus in front of the esophagus as shown in Plate 81 O, P and Q is essential when the shape of the hiatus is that of an ellipse, thus leaving a triangular defect in front. In the majority of instances, however the hiatus is U or horseshoe shaped with a rounded contour in front. In these it is necessary merely to place a few sutures behind the esophagus.

The situation illustrated in Plates 84 and 85 appears to be somewhat theoretical. I have never encountered it. With any anomaly of the diaphragm at the esophageal hiatus, a thorough knowledge of the normal anatomy should make it possible to impro-
satisfactory technic for closure

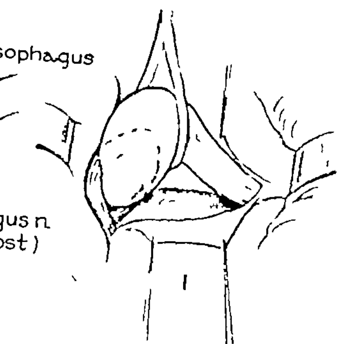
Hernia and overlying phrenoesophageal lig

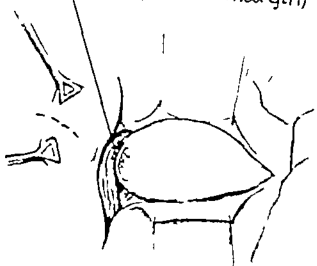
Esophagus

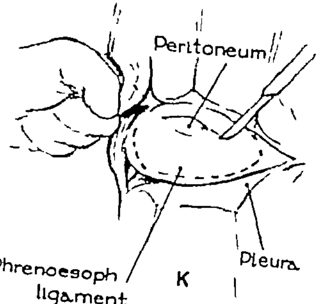
R vagus n (post)

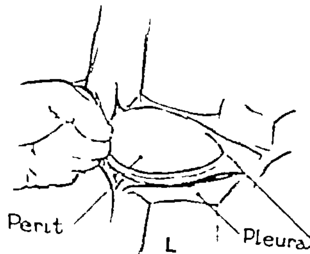
H

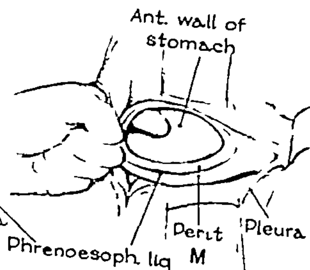
Pleura











N The hernia is reduced either by traction through the diaphragm as shown or by downward displacement with the aid of a pledget of gauze held in a ring clamp (P) If desired a combination of both maneuvers may be used.

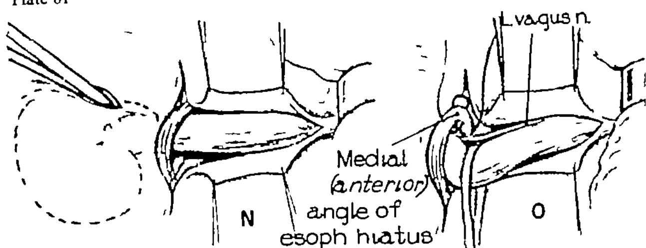
O After reduction of the hernia, the esophagus is retracted laterally (posteriorly) and the innermost or "crown" suture is inserted. This suture approximates the muscle fibers of the right crus which forms the medial (anterior) angle of the hiatal ring. This angle is in juxtaposition to both the tendinous portion of the diaphragm and the inferior phrenic vein. Accordingly caution should be observed in the placement of sutures to avoid injury to the inferior phrenic vein. A second suture in this area may or may not be required.

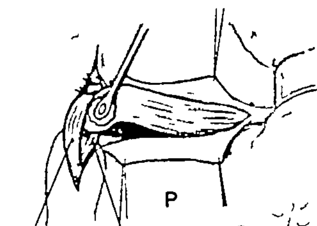
P Q The esophagus is displaced medially (anteriorly) and the lateral (posterior) sutures (No 1 silk) are inserted. These sutures approximate not the right and left crura as so commonly thought but the superficial and deep muscle layers of the right crus of the diaphragm which form the right and left margins respectively of the esophageal hiatal ring. The muscle fibers of the superficial layer (right margin of the esophageal hiatus) are frequently thinned out and have a poor holding power Accordingly in the suture approximation of the superficial and deep layers of the muscle fibers of the right crus, tension on the suture line should be avoided. When completed, the closure of the hiatal ring is snug but not too tight.

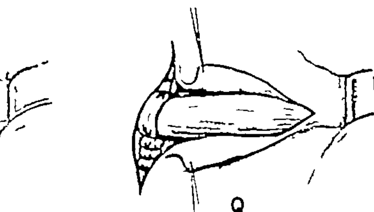
R. The incision in the diaphragm is closed (00 silk) and the flaps of diaphragmatic pleura are approximated with sutures of fine silk (0000) The posterior mediastinal pleura is not sutured because, in the event of an infection, the more readily treated complication, a pleural empyema, rather than a mediastinal abscess would then occur

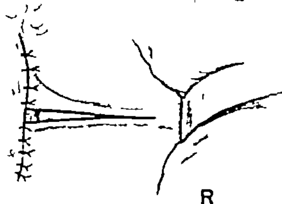
S T U Two pericostal sutures of silk (No 3) or if preferred double strands of chromic catgut (No 2), are used to approximate the rib cage, and the muscle layers of the wound are closed with interrupted sutures of silk (000) Periosteal "windows" are formed along the inferior border of the lower rib to prevent impingement upon either the intercostal nerve or the sensitive periosteum A water-seal catheter drainage of the pleural cavity is routinely employed. This catheter is withdrawn approximately 36 hours postoperatively

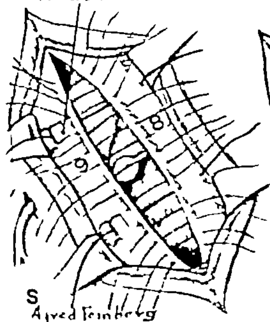
Plate 81

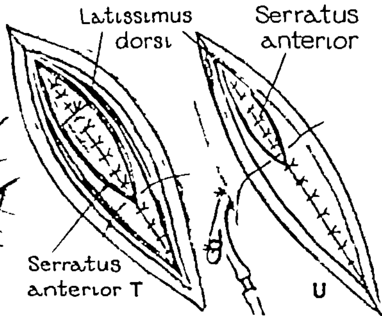

L vagus n.
Medial (anterior) angle of esoph hiatus
N
O


P
Thick left margin
Thin right margin
Hiatal ring


Q


R


Periosteal window
8
9
S


Latissimus dorsi
Serratus anterior
Serratus anterior T
U

These illustrations depict diagrammatically the three most commonly used methods in the repair of a hernia through the esophageal hiatus of the diaphragm.

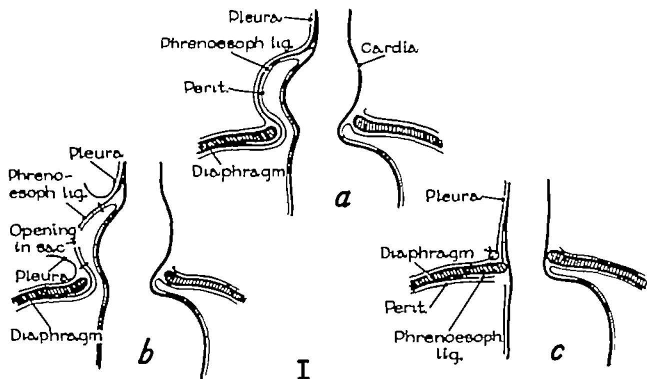
I. *a.* The anatomic pathologic findings in a sliding hernia through the esophageal hiatus are shown. The posterior wall of the sac is formed by the protruding viscus, the stomach, and thereby conforms to the definition of a sliding hernia.

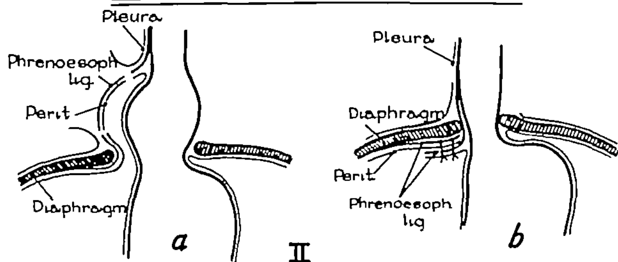
b. The posterior mediastinal pleura, the phrenoesophageal ligament, and the peritoneum are incised to enter the lumen of the hernial sac. The extent of the resection of the phrenoesophageal ligament and the peritoneum is indicated by the small solid black lines.

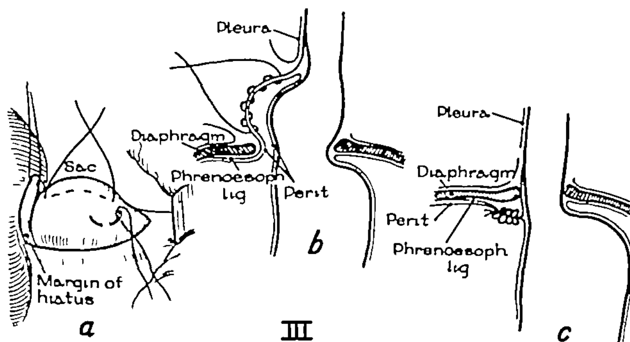
c. The herniated segment of the stomach into the posterior mediastinum is reduced, and the superficial and deep muscle layers of the right crus of the diaphragm are approximated around the esophagus just above the cardia. The diaphragmatic pleura, but not the opening in the posterior mediastinal pleura, is sutured. This method of repair of a sliding hernia is the same as shown in the preceding artist's illustrations.

II. *a, b.* These sketches demonstrate an essential step in the Allison method of repair. Following the excision of segments of the phrenoesophageal ligament and the peritoneum (anterior wall of the sac), the cuff formed by the proximal cut margins of the phrenoesophageal ligament and peritoneum is sutured to the under surface of the diaphragm. Another important step in the Allison method, although not illustrated in the sketches, is the closure of the muscular hiatal ring in a vertical plane "with the grain," posterior to the esophagus.

III. *a, b, c.* These sketches outline the essential steps in the technic advocated by Sweet for the repair of small and medium sized hernias. A series of circumferential or longitudinal plication sutures are inserted in the overlying phrenoesophageal ligament and peritoneum to obliterate the sac. The closure of the lax muscle ring of the hiatus about the esophagus completes the repair of the hernia.


Pleura
Phrenoesoph lig
Cardia
Perit.
Diaphragm
a
Pleura
Phreno-
esoph lig
Opening
in sac
Pleura
Diaphragm
b
Pleura
Diaphragm
Perit.
Phrenoesoph
lig.
c
I


Pleura
Phrenoesoph
lig
Perit
Diaphragm
a
II
Pleura
Diaphragm
Perit
Phrenoesoph
lig
b


Pleura
Diaphragm
Phrenoesoph
lig
Perit
Sac
Margin of
hiatus
a
b
III
Pleura
Diaphragm
Perit
Phrenoesoph
lig
c

The modification of the Allison method which is now used routinely as the preferred technic in the repair of an esophageal hiatus hernia is illustrated. The main modification is that the proximal cuff formed by the phrenoesophageal ligament and the peritoneum is sutured to the upper rather than the under surface of the diaphragm. Technically this is simpler and it is believed not to lessen the anchorage effect on the esophagus

The modification of Allison s method, recently suggested by Johnsrud, has much to recommend it. In this technic the phrenoesophageal ligament and the peritoneum forming the anterior wall of the hernial sac is not incised but instead inverted through the esophageal hiatus into the peritoneal cavity The double thickness of the wall of the inverted hernial sac is then sutured to the under surface of the diaphragm with a series of interrupted silk sutures

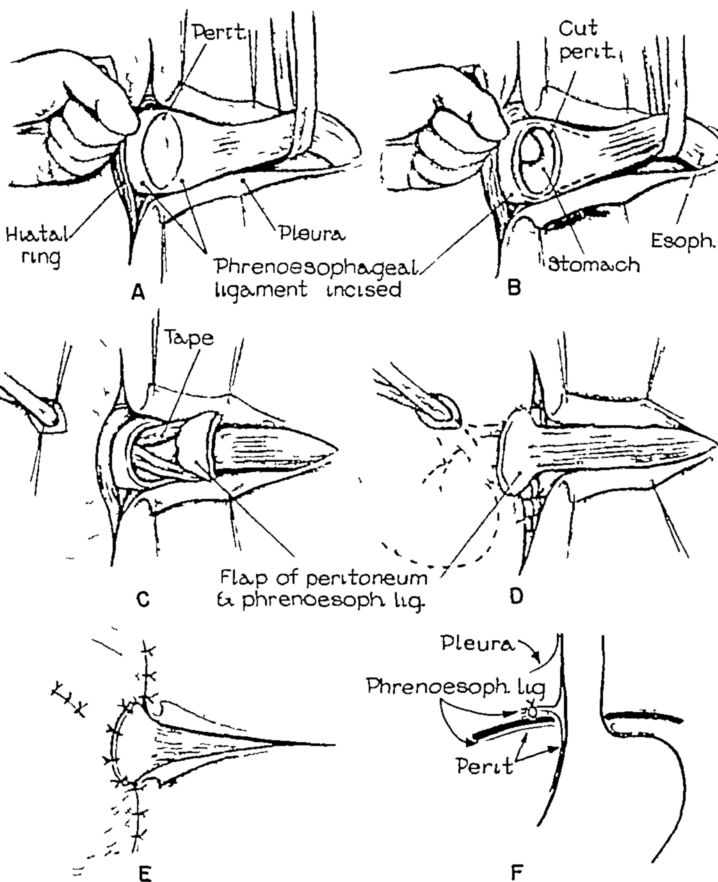
A. Through an incision in the diaphragm, the index finger is inserted into the peritoneal cavity and then through the esophageal hiatus into the lumen of the sac. The phrenoesophageal ligament is incised, and the underlying peritoneal layer is tented on the tip of the index finger

B The peritoneal layer which forms the anterior wall of the sac is incised, and the lumen of the hernial sac is entered The anterior wall of the stomach which forms the posterior wall of the sac is visible A cuff of the phrenoesophageal ligament and peritoneum is formed proximally by making the incisions indicated by the dotted lines

C D The ends of the traction tape of rubber tissue which encircles the esophagus are withdrawn through the esophageal hiatus into the peritoneal cavity and then through the opening in the diaphragm into the pleural cavity By traction on this tape the hernia is reduced into the peritoneal cavity and the muscle bundles of the right crus which form the boundaries of the esophageal hiatus are approximated both medial (anterior) and lateral (posterior) to the esophagus.

E. The proximal cuff formed by the phrenoesophageal ligament and peritoneal layers is sutured to the upper or pleural surface of the diaphragm for anchorage of the esophagus. The incision in the diaphragm is closed and the flap of diaphragmatic pleura, but not the mediastinal pleura, is sutured.

F A diagrammatic illustration of the completed operation is shown in profile


Perit.
Cut
perit.
Hiatal
ring
Pleura
Phrenoesophageal
ligament incised
Stomach
Esoph.
A
B
Tape
Flap of peritoneum
& phrenoesoph. lig.
C
D
Pleura
Phrenoesoph. lig
Perit
E
F

Allison emphasized the importance of closure of the hiatal ring in a vertical plane posterior to the esophagus. In the succeeding illustrations the difficulty in performing this method of closure when the long axis of the hiatus is in the transverse or horizontal plane is shown.

A. The esophageal hiatus viewed from the lower or abdominal surface of the diaphragm. The dilated hiatal ring prior to *closure is demonstrated. The long axis of* the ring is in a horizontal plane.

B. The excessive angulation and tension on the suture line and the inadequacy of the closure on attempted approximation of the muscle layers of the right crus in a vertical plane posterior to the esophagus are shown.

C D *The muscle fibers of the right crus are* approximated in a horizontal plane to the left of the esophagus. The closure is adequate and there is a minimum of tension on the suture line.

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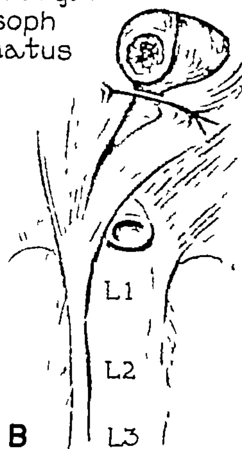
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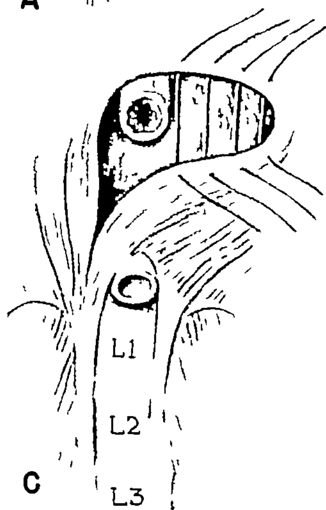
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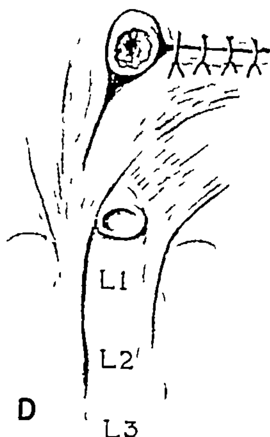
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Esophagus
Rt margin esoph hiatus
Lt margin esoph hiatus
Right crus
Left crus
Aorta
L1
L2
L3
A







The same illustrations as in Plate 84 when viewed from the upper or thoracic surface of the diaphragm with the patient in the direct right lateral prone position.

A. The thick layer of muscle fibers of the right crus, the left margin of the hiatal ring, crossing superficial to the thin layer of muscle fibers of the right crus, the right margin of the hiatal ring, is shown. The long axis of the hiatus is in the left lateral or horizontal plane.

B. The excessive angulation and tension on the suture line and the inadequate closure on attempted approximation of the muscle fibers of the right crus in a vertical plane posterior to the esophagus is demonstrated.

All too frequently artist's illustrations depicting the transthoracic approach for the repair of an esophageal hiatus hernia will show the thoracic incision being properly made with the patient in the right lateral prone position. But when the left pleural cavity is entered, the anatomic relations of the hiatal ring and the method for its closure are illustrated as if the patient were supine. It is believed that such illustrations are perpetuations of error which have led to needless confusion and misunderstanding of both the anatomy of the hiatal ring and the methods of surgical repair. The surgeon should remember that in the transthoracic approach, with the patient in the right lateral prone position, the posterior angle of the hiatal ring is always facing toward him. Furthermore, it is at this angle that the crossing of the fibers of the right crus occurs (A).

Commonly in the transthoracic approach, closure of the hiatal ring in the lateral plane to the left of the esophagus (C) is described as anterior to the esophagus. Similarly, closure in the opposite or right lateral plane (D) is described as posterior to the esophagus. However, a careful study of the comparative relation of the hiatal ring to the esophagus in the supine (Plate 84) and in the right lateral prone positions (Plate 85) should aid in the correction of these anatomic misinterpretations.

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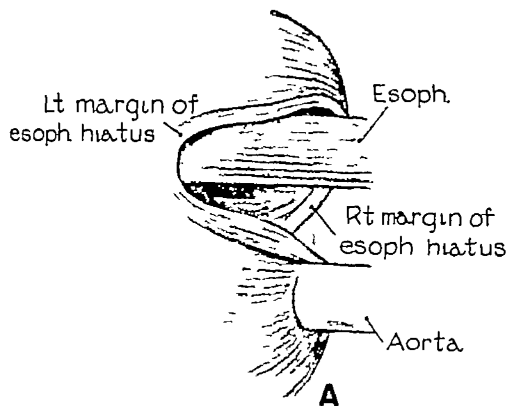
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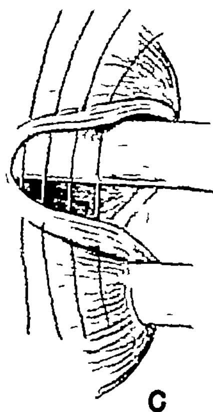
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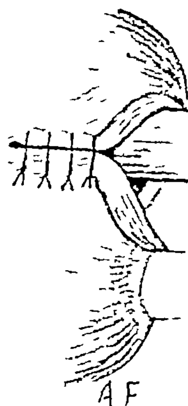
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Lt margin of esoph hiatus
Esoph.
Rt margin of esoph hiatus
Aorta
A




C


A F

THE TRANSABDOMINAL APPROACH FOR THE REPAIR OF AN ESOPHAGEAL HIATUS HERNIA

A. The patient is placed in the supine position, and the incision of choice, a long left paramedian muscle retracting (lateral) incision, is outlined.

B. The peritoneal cavity is entered, and the related intraperitoneal viscera are demonstrable. By manual retraction the *left lobe* of the liver is displaced downward toward the midline, and its mobilization is commenced by the severance of the avascular *left triangular ligament. In some instances* the left lobe of the liver is elongated and the left triangular ligament is markedly foreshortened. Under such circumstances the esophagocardial region is exposed by the retraction upward of the left lobe of the liver the *surface of which is protected by a* moist gauze pad.

C. The mobilized left lobe of the liver is turned downward and inward on itself and after being covered with a moist gauze pad, it is retracted medialward. By manual traction *the herniated segment of the stomach into* the posterior mediastinum through the esophageal hiatus is reduced and the layer of peritoneum overlying the esophagocardial junction is severed by scissor dissection.

D. The posterior mediastinal space is entered and the terminal portion of the esophagus, mobilized previously by digital dissection, is encircled by a rubber tissue drain for the purpose of traction.

E. The reduction of the hernia is maintained by downward traction. The terminal 4 cm. of the esophagus is exposed, and its relation to the vagus nerves and the right and left margins of the esophageal hiatus *formed by the superficial and deep muscle* layers respectively of the right crus of the diaphragm are demonstrated.

F. The esophagus is displaced to the left to show the enlarged esophageal hiatus and its *formation by the separation of the fibers of* the right crus into thin superficial (right margin) and thick deep (left margin) muscle layers.

G. The superficial and deep muscle layers of the right crus of the diaphragm, the right *and left margins respectively of the hiatal* ring, are approximated in a slightly oblique plane posterior to the esophagus, using two or three interrupted sutures of silk (No. 1). In this approximation, tension on the suture line should be avoided.

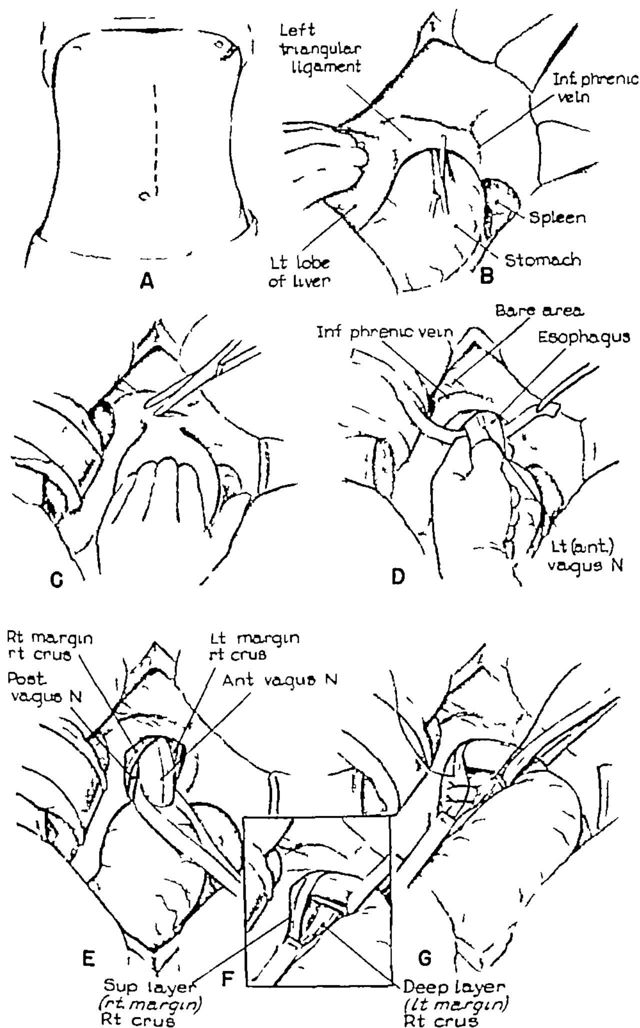
DISCUSSION—DR. SWEET (cont.)

The *abdominal approach* for the repair of a hiatus *hernia is well illustrated in Plate 86. Here also* precise knowledge of the anatomy is absolutely essential. In fact, the failures which result from the use of this approach are undoubtedly due to inaccuracy in dealing with the structures involved. As with all surgery, a wide exposure of the operative field must be obtained. It is this aspect of the employment of the *abdominal approach which creates the greatest* technical problem.

The incision must be long and must reach upward to the costoxiphoid angle (Plate 86, A). So also the left lobe of the liver must be retracted away from the operative field. This step requires the division of the left triangular ligament and the folding under of the liver edge as shown in Plate 86 (B and C).

It should be stressed also that, with the abdominal *approach as with the thoracic, the margins of* the hiatus must be exposed to view so that sutures can be inserted in the muscle bundles. This is best accomplished by retracting the esophagus to the left (Plate 86, F and G).

Little remains of the peritoneal sac after the dissection necessary to expose the lower esophagus and *the muscle bundles of the right crus has been* completed, but nothing much need be done about it. Any redundant edges of peritoneum, however, can be trimmed away and the peritoneal layer closed with sutures which attach it to the undersurface of the diaphragm as an additional safeguard against recurrence.


Left triangular ligament
Inf. phrenic vein
Spleen
Stomach
Lt lobe of liver
A
B
C
D
Bare area
Inf phrenic vein
Esophagus
Lt (ant.) vagus N
Rt margin rt crus
Lt margin rt crus
Post. vagus N
Ant vagus N
E
F
G
Sup layer (rt. margin) Rt crus
Deep layer (lt margin) Rt crus

EVENTRATION OF THE DIAPHRAGM

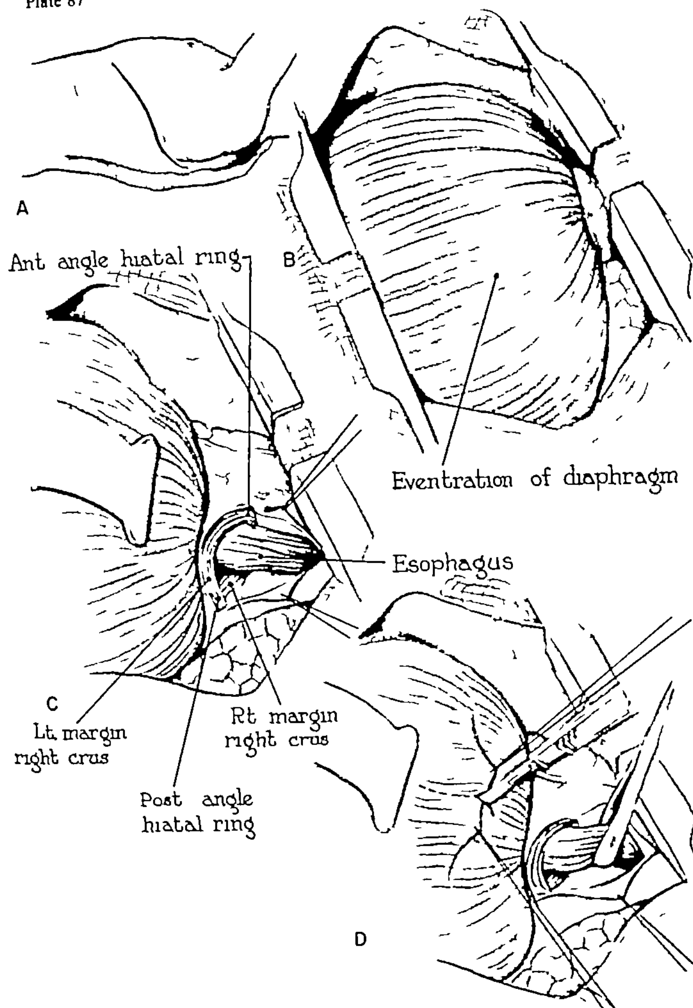
A. The patient is placed in the direct right lateral prone position, and the incision overlying the eighth rib is indicated by the solid line.

B. The elevated left leaflet of the diaphragm which caused a compression atelectasis of the lower lobe of the left lung is shown. Despite the high elevation of the diaphragmatic leaflet, its muscle tone was surprisingly good. No tendinous portion was visible.

C. The diaphragm is retracted downward, and the flaps of the posterior mediastinal and diaphragmatic pleura are raised to expose the lower portion of the esophagus and the muscular esophageal hiatal ring. This ring is formed by a separation of the muscle fibers of the right crus into two layers, superficial and deep. The superficial layer forms the right margin and the deep layer the left margin of the esophageal hiatus. From the thoracic approach as illustrated, the thick layer of fibers which forms the left margin crosses superficial to the thin layer of fibers which forms the right margin of the hiatus. The reverse is true when the hiatus is viewed from the abdominal side with the patient supine. It should also be observed that with the patient in the right lateral prone position, the posterior angle of the esophageal ring is directed toward the surgeon. This anatomic point is stressed because it is so frequently misrepresented in artist's illustrations. In this patient a concomitant finding was a small sliding hiatus hernia.

D. The lower portion of the esophagus is encircled by a cotton tape for traction, and the left leaflet of the diaphragm, tented by guy sutures of silk (000) is incised. The incision is subsequently extended by scissor dissection as indicated by the dotted line.

Plate 87

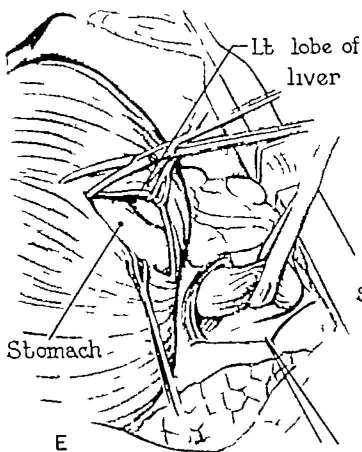

A
B
C
D
Ant angle hiatal ring
Eventration of diaphragm
Esophagus
Lt. margin right crus
Rt margin right crus
Post angle hiatal ring

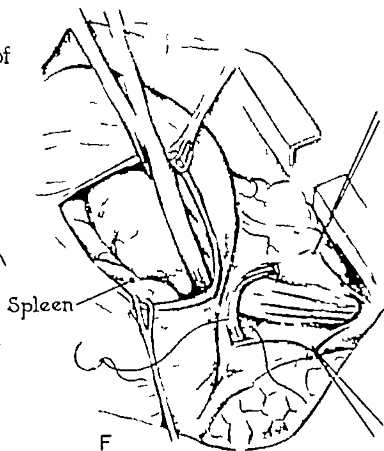
E. The incised margins of the diaphragm are grasped in Babcock clamps and the scissor dissection is continued. Underlying portions of the stomach and the left lobe of the liver are visible

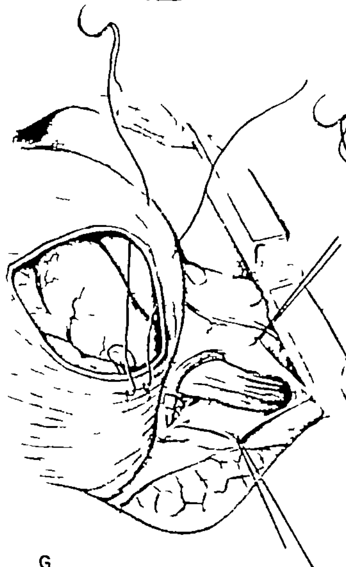
F. The long ends of the cotton tape which encircle the lower portion of the esophagus are passed through the hiatus into the peritoneal cavity and then through the opening in the diaphragm into the left pleural cavity. By traction on the tape the small herniated segment of the stomach is reduced, and the closure of the hiatal ring posteriorly is begun by the insertion of a suture of No 1 silk. In this illustration the anterior border of the spleen is visible.

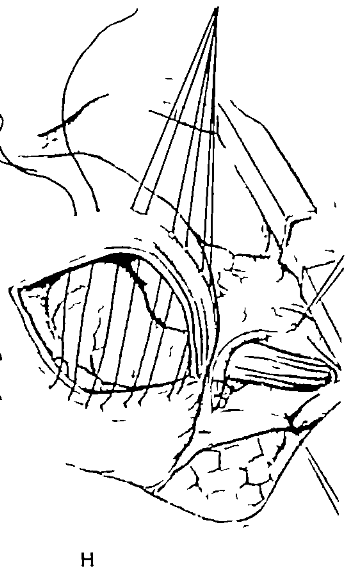
G. The closure of the hiatal ring posteriorly using two interrupted sutures of silk (No 1) is completed, and the insertion of the imbricating mattress sutures of silk (0) for the repair of the eventration of the diaphragm is begun.

H. All but one of the imbricating mattress sutures are inserted. The insertion of these sutures is begun farther from the incised margin of the diaphragm anteriorly than posteriorly so that, when they are tied, an overlap (imbrication) of the cut margins of the diaphragm is obtained.


Lt lobe of liver
Stomach
E


Spleen
F


G


H

I. The imbricating mattress sutures of silk are tied, and the excess of the overlapping portion of the diaphragm is excised as indicated by the dotted line.

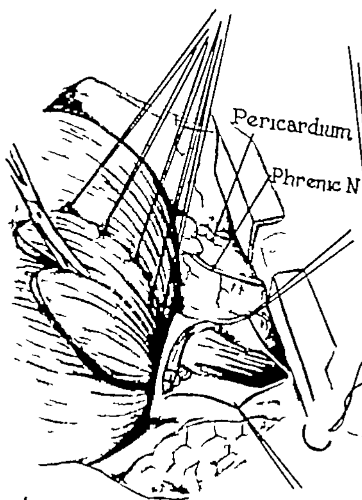
J. The free cut margin of the overlapping portion of the left leaflet of the diaphragm is sutured to its subjacent portion with interrupted sutures of 0 silk.

K, L. In this patient some laxity of the diaphragm persisted following the repair as depicted. Accordingly a secondary inversion layer of interrupted sutures of 0 silk was first inserted (K) and the sutures then were tied (L). Following the completion of this procedure, the relation of the left leaflet of the diaphragm to its opposite side and to the adjacent intrapleural structures appeared normal. The lower lobe of the left lung was easily expanded to its full capacity and the flaps of diaphragmatic pleura were approximated with interrupted sutures of silk (000). The flaps of posterior mediastinal pleura were not sutured. Accordingly in the event of an infection a complicating pleural empyema which is easily drained rather than a mediastinal abscess which is difficult to drain would most likely occur

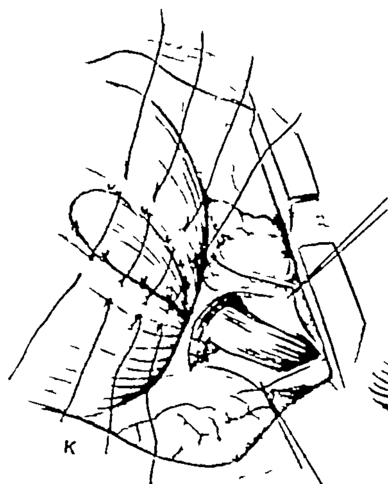
This patient, a 63-year-old obese white man, was admitted to the hospital because of massive gastrointestinal bleeding. A gastrointestinal series revealed a true "upside-down" stomach associated with a high elevation of the left leaflet of the diaphragm as depicted in the illustrations The summit of the elevation was at the level of the third rib anteriorly Because of the severity of the hemorrhage and the previous history of symptoms consistent with the diagnosis of a duodenal ulcer operation was advised. Although the relation of the esophagocardial junction to the hiatal ring appeared normal in the roentgenograms at operation there was an associated small esophageal hiatal hernia of the sliding variety In addition to the surgical correction of the eventration of the diaphragm as illustrated, a transdiaphragmatic antecolic gastrojejunostomy in conjunction with a transthoracic partial resection of the vagus nerves, was done. Postoperative roentgenograms of the chest revealed normal position and mobility of the left leaflet of the diaphragm.

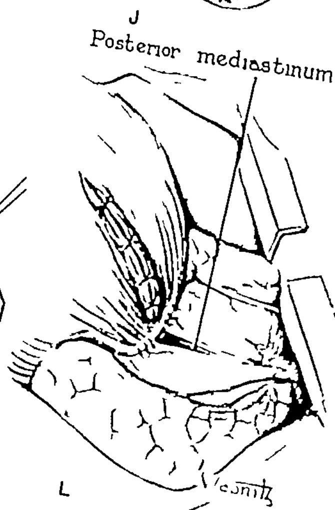
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Pericardium
Phrenic N
I


J


K


Posterior mediastinum
L

TRANSTHORACIC SUPRADIAPHRAGMATIC RESECTION OF THE VAGUS NERVES

A. The patient is placed in the direct right lateral prone position, and a relatively short incision in the eighth interspace, extending from the anterior to the posterior axillary lines is outlined.

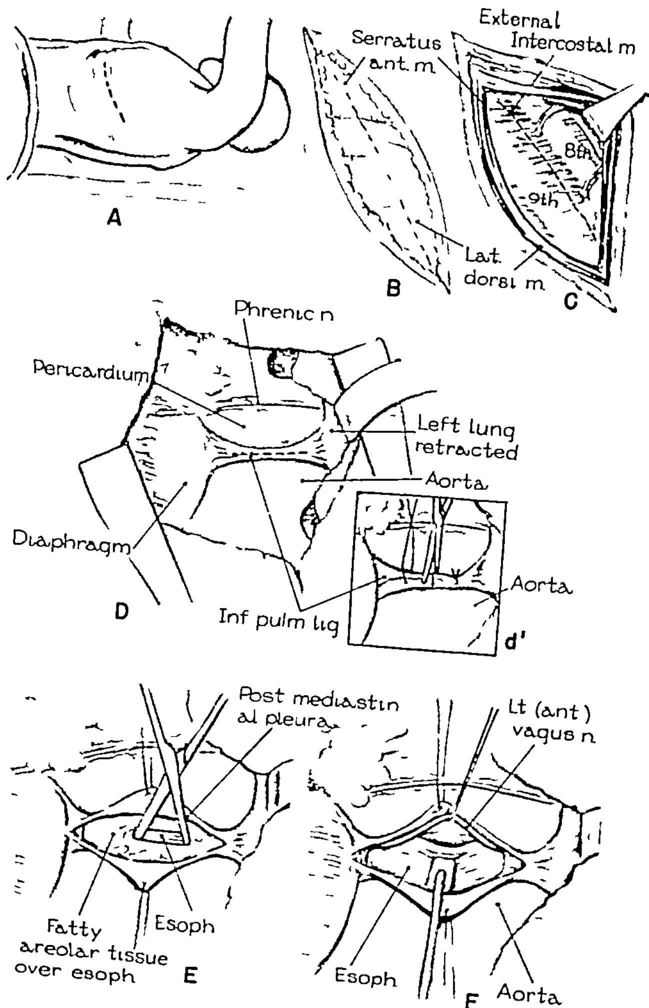
B, C. The incision is deepened through the underlying muscle layers and the left pleural cavity is entered (D).

D. The adjacent rib margins are retracted and the entrance into the posterior mediastinal space through an incision in the reflection of the pleura forming the inferior pulmonary ligament is shown

d An inset to demonstrate an alternate method of incising the inferior pulmonary ligament between suture ligatures of silk (000)

E. The cut margins of the posterior mediastinal pleura are reflected by guy sutures of silk (0000) and by blunt scissor dissection an opening is made in the avascular fatty areolar tissue overlying the esophagus.

F The esophagus is displaced posteriorly and the left or anterior vagus nerve is mobilized on a nerve hook. This nerve, smaller than the right, is always in close approximation to the anterior surface of the esophagus


A
Serratus ant. m
External Intercostal m
8th
9th
Lat. dorsi m
B
C
Phrenic n
Pericardium
Left lung retracted
Aorta
Diaphragm
Aorta
D
Inf pulm lig
d'
Post mediastin al pleura
Lt (ant) vagus n
Fatty areolar tissue over esoph
Esoph
E
Esoph
F
Aorta

TRANSTHORACIC, SUPRADIAPHRAGMATIC RESECTION OF THE VAGUS NERVES

A. The patient is placed in the direct right lateral prone position, and a relatively short incision in the eighth interspace, extending from the anterior to the posterior axillary lines, is outlined.

B C. The incision is deepened through the underlying muscle layers and the left pleural cavity is entered (D).

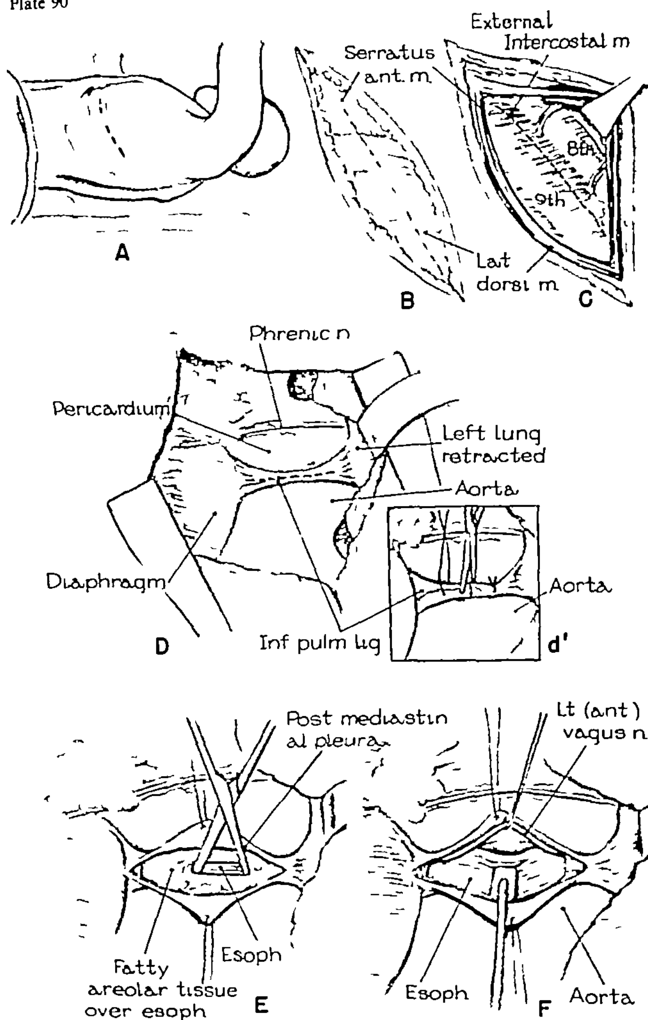
D The adjacent rib margins are retracted and the entrance into the posterior mediastinal space through an incision in the reflection of the pleura forming the inferior pulmonary ligament is shown.

d An inset to demonstrate an alternate method of incising the inferior pulmonary ligament between suture ligatures of silk (000).

E. The cut margins of the posterior mediastinal pleura are reflected by guy sutures of silk (0000) and by blunt scissor dissection, an opening is made in the avascular fatty areolar tissue overlying the esophagus.

F The esophagus is displaced posteriorly and the left or anterior vagus nerve is mobilized on a nerve hook. This nerve, smaller than the right, is always in close approximation to the anterior surface of the esophagus.

Plate 90


A
External
Intercostal m
Serratus
ant. m.
8th
9th
Lat
dorsi m.
B
C
Phrenic n
Pericardium
Left lung
retracted
Aorta
Aorta
Diaphragm
D
Inf pulm lig
d'
Post mediastin
al pleura
Lt (ant)
vagus n
Fatty
areolar tissue
over esoph
Esoph
E
Esoph
F
Aorta

TRANSTHORACIC SUPRADIAPHRAGMATIC RESECTION OF THE VAGUS NERVES

A The patient is placed in the direct right lateral prone position, and a relatively short incision in the eighth interspace, extending from the anterior to the posterior axillary lines, is outlined.

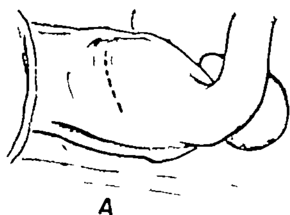
B C. The incision is deepened through the underlying muscle layers and the left pleural cavity is entered (D)

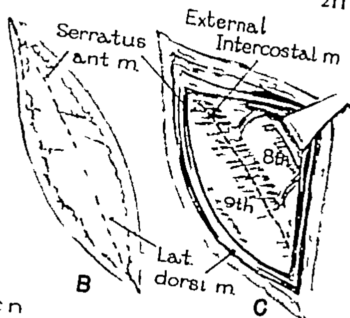
D The adjacent rib margins are retracted and the entrance into the posterior mediastinal space through an incision in the reflection of the pleura forming the inferior pulmonary ligament is shown

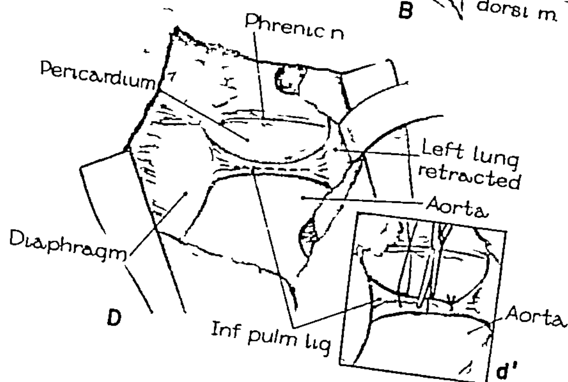
d An inset to demonstrate an alternate method of incising the inferior pulmonary ligament between suture ligatures of silk (000)

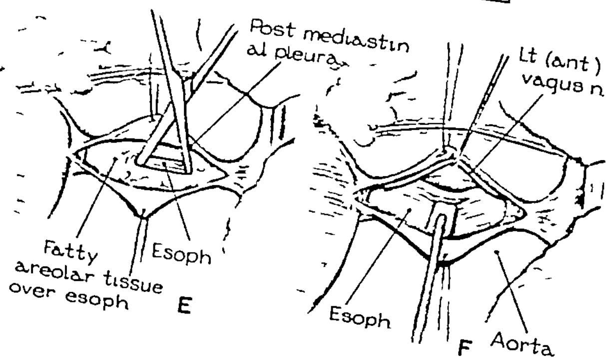
E. The cut margins of the posterior mediastinal pleura are reflected by guy sutures of silk (0000) and by blunt scissor dissection, an opening is made in the avascular fatty areolar tissue overlying the esophagus.

F The esophagus is displaced posteriorly and the left or anterior vagus nerve is mobilized on a nerve hook. This nerve, smaller than the right, is always in close approximation to the anterior surface of the esophagus.


A


Serratus
ant m
External
Intercostal m
8th
9th
Lat.
dorsi m
B
C


Phrenic n
Pericardium
Left lung
retracted
Aorta
Diaphragm
Aorta
D
Inf pulm lig
d'

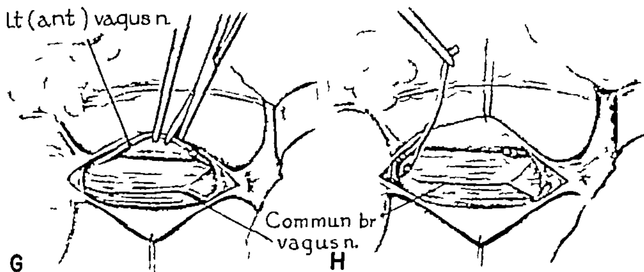

Post mediastin
al pleura
Lt (ant)
vagus n
Fatty
areolar tissue
over esoph
Esoph
E
Esoph
F
Aorta

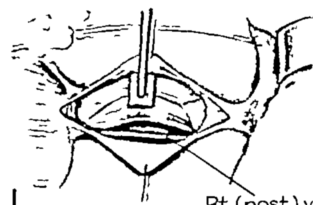
G, H A segment of the left (anterior) vagus nerve is removed between demarcating silver clips. *A communicating branch of* the vagus nerve is visible.

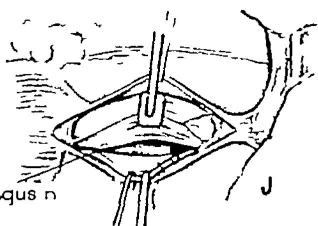
I J K The esophagus is displaced anteriorly to visualize the right (posterior) vagus nerve which *lies in the fatty areolar tissue plane* posterior and medial to the esophagus. Similarly as previously demonstrated, a segment of this nerve is resected

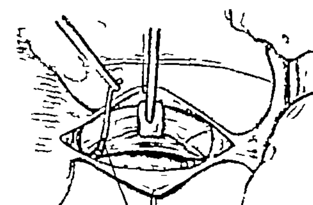
L. The communicating branch is mobilized on a nerve hook preliminary to its severance. Subsequently careful digital exploration of the complete circumference of the esophagus is performed to detect and sever all of the additional nerve fibers which may be present. The importance of this maneuver cannot be overemphasized since the success *of the operation is dependent upon the com*pleteness of the vagal denervation of the stomach.

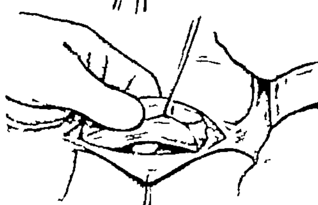
M N O The layer closure of the incision is illustrated. *Just prior to the completion of* the closure the water-seal drainage catheter is removed. Two periosteal flaps are raised at the lower border of the ninth rib to permit the insertion of the pericostal sutures (No 2 silk) without impingement upon the subjacent intercostal nerve. It is believed that the use of this technic may lessen the incidence of post thoracotomy pain. If preferred, heavy sutures of chromic catgut may be used for the pericostal sutures.

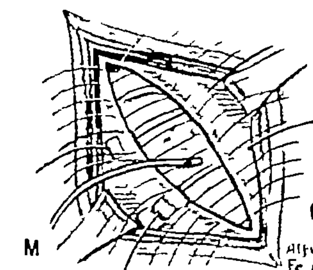

Lt (ant) vagus n.
Commun br vagus n.
G
H

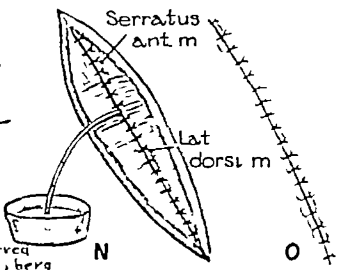

I
Rt (post) vagus n


J


K
Rt (post.) vagus n


L


M


Serratus ant. m
Lat dorsi m
N
O

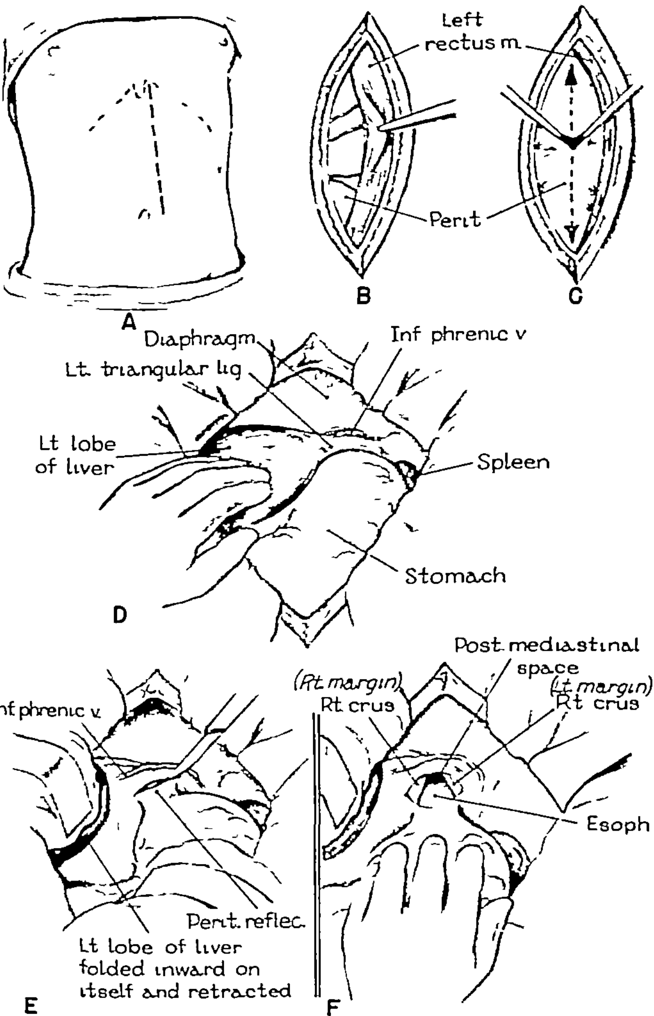
INFRADIAPHRAGMATIC RESECTION OF THE VAGUS NERVES AND ANTECOLIC GASTROJEJUNOSTOMY

A B C. The peritoneal cavity is entered through a left paramedian muscle-retracting (lateral) incision.

D The wound margins are retracted, and the structures in the region of the esophago-cardial junction are shown The site of severance of the avascular left triangular ligament is shown in dotted outline. In some instances this ligament may be too short to sever Under such circumstances, a moist protective pad is placed beneath the left lobe of the liver which is gently retracted upward.

E, F An incision is made through the peritoneal and fascia layers overlying the lowermost portion of the esophagus, and the posterior mediastinal space is entered. The relation of the esophagus to the margins of the right crus of the diaphragm which form completely the esophageal hiatal ring is shown.

DISCUSSION—DR LESTER R DRAGSTEDT In the transabdominal approach for resection of the vagus nerves, it has been my usual practice to divide the triangular ligament to the left lobe of the liver as illustrated in D Plate 92 I believe that this gives better access to the lower portion of the esophagus However some surgeons of experience including Dr Joseph Weinberg of Los Angeles, omit this step and retract the left lobe of the liver upward with a large broad blade retractor In entering the mediastinum, I have found it wise to make the opening midway between the esophageal hiatus and the large inferior phrenic vein, as demonstrated in the illustrations E and F Plate 92. I customarily do this by picking up the diaphragm with forceps with protruding teeth making a small nick with a pair of scissors, and


A
Left
rectus m.
Perit
B
C
Diaphragm
Inf phrenic v
Lt. triangular lig
Lt lobe
of liver
Spleen
Stomach
D
Post. mediastinal
space
(Rt margin)
(Lt margin)
Rt crus
Rt crus
Inf phrenic v.
Esoph
Perit. reflec.
Lt lobe of liver
folded inward on
itself and retracted
E
F

G. The lower end of the esophagus is mobilized by blunt digital dissection and encircled by a rubber tissue traction tape. The left anterior vagus nerve which is always in close relation to the anterior surface of the esophagus is visible.

H I The esophagus is displaced to the left by traction, and the right or posterior vagus nerve located in the fibroareolar tissue posterior and medial to the esophagus is mobilized on the right index finger and secured on a nerve hook.

J The right (posterior) vagus nerve is divided with scissors between a silver clip marker above and a clamp below

K. The left (anterior) vagus nerve is similarly divided, and careful digital exploration of the periesophageal region for additional nerve fibers is being performed. This is considered a most important part of the operation. A minimum of 3 and a maximum of 13 additional nerve fibers have been identified by this maneuver

L. The duodenojejunal junction at the base of the transverse mesocolon as indicated by the ligament of Treitz, is visualized, and a segment of jejunum, 9 to 12 inches distally is isolated by two guy sutures of silk.

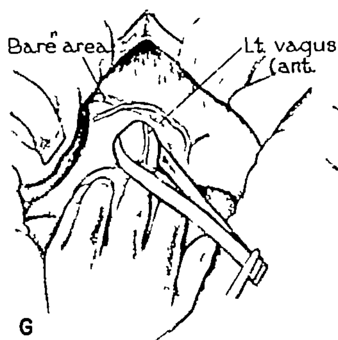
Discussion—Dr. Dragstedt (cont.)

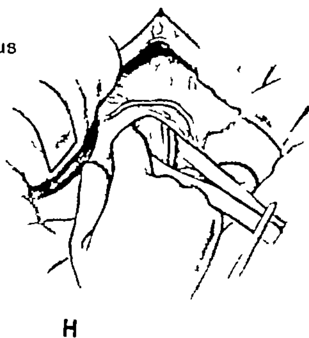
then thrusting the scissors into the mediastinum, thus enlarging the opening. Sometimes I think this may avoid troublesome hemorrhage.

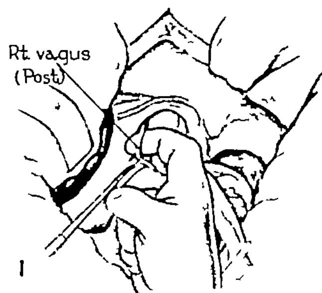
In mobilizing the esophagus by blunt finger dissection it is important to emphasize that this be done gently Several cases have been reported where the esophagus has been opened with rough handling. Upon mobilization of the esophagus it is my practice to sweep the fingers of the right hand around the esophagus in an effort to include all of the vagus fibers within their grasp The esophagus and vagus nerves are then pulled downward into the abdomen whereupon the posterior vagus nerve which is felt against the yielding esophagus, is pulled over to the left and a segment excised between ligatures of non absorbable suture material. The use of silver clips is equally satisfactory

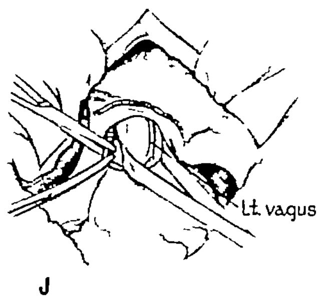
If a gastrojejunostomy rather than pyloroplasty is selected as a drainage procedure, I believe it is wise to place the gastroenterostomy stoma within five or six cm of the pylorus. We have encountered a number of patients where a high lying gastrojejunostomy failed to drain adequately the antrum of the stomach, and the stasis of food in this area caused an excessive secretion of gastric juice of humoral or hormonal origin. It has also been my practice to make a small gastroenterostomy opening so that when the operation is completed the stoma is approximately one-and-one half cm. in diameter It is my conviction that such a small stoma decreases the incidence and severity of the dumping syndrome.

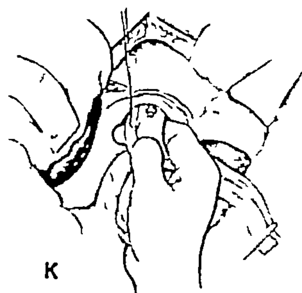
The transthoracic approach for division of the vagus nerves, such as indicated in the illustrations of this operation, was the method that I first employed. However this operation has been very largely abandoned by me because it does not provide an opportunity to add a drainage procedure to the vagotomy it does not permit inspection of the ulcer and possible associated pathology and because of the frequency of postoperative intercostal pain. This approach, however may be used for the treatment of recurrent gastrojejunal ulcers after repeated gastric resection and possibly in some other special situation.

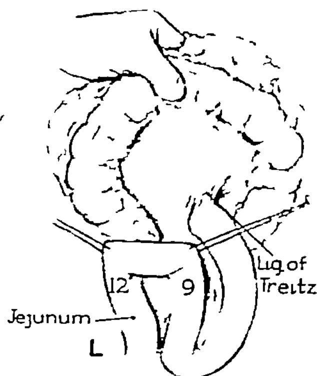

Bare area
Lt. vagus (ant.
G


H


Rt. vagus (Post.)
I


Lt. vagus
J


K


Lig. of Treitz
12
9
Jejunum
L

M N A segment of the anterior wall of the stomach in juxtaposition to the most dependent portion of the greater curvature is mobilized by Babcock clamps, and the anterior gastric branches of the gastroepiploic arch are serially clamped, severed, and ligated.

O The anterior and all but one of the posterior gastric branches of the gastroepiploic arch have been severed and ligated, and the lesser sac is entered.

P The segment of jejunum previously isolated is brought anterior to the transverse colon and approximated to the posterior wall of the greater curvature of the stomach by a series of interrupted silk (000) sutures If preferred, the jejunum may be brought through an opening in an avascular portion of the transverse mesocolon and a "short loop" retrocolic gastrojejunostomy performed. The sites of incision in the jejunum and in the avascular plane of the greater curvature of the stomach are indicated in dotted outline. No clamps are used in the performance of the anastomosis. This is the preferred technic

p Inset to show the relation of the first posterior layer of sutures to the mesenteric border of the jejunum.

Q Incisions are made through the seromuscular layers of the jejunum and the greater curvature of the stomach, and the vessels in the submucosal layers are undersewn with hemostatic suture ligatures of silk (0000)

R The lumen of the stomach is first entered by an incision with a scalpel, and the opening is extended by scissor dissection. The opening, similarly made previously into the lumen of the jejunum, is visible. Soiling of the operative field with either gastric or jejunal contents is minimized by aspiration with the suction tube.

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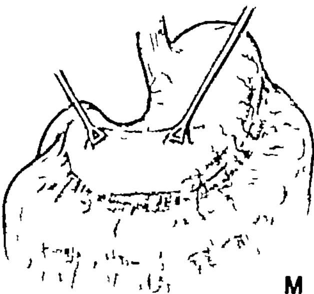
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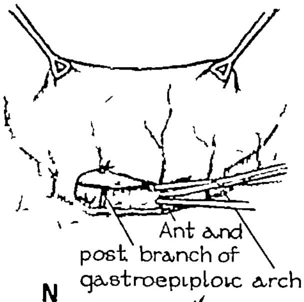
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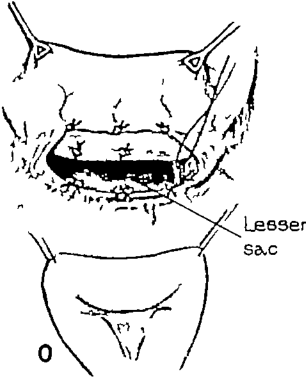
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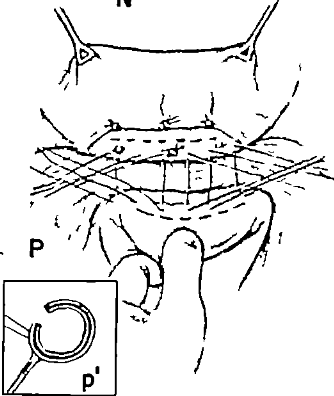
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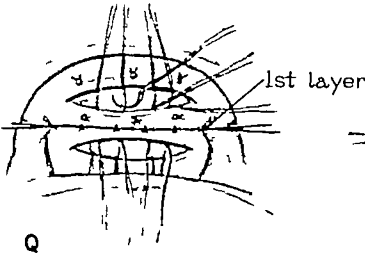
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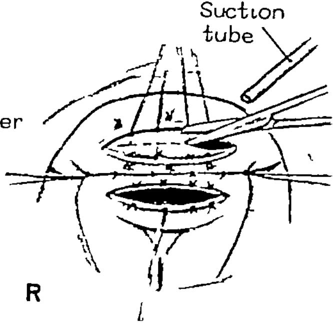

M


N
Ant and
post branch of
gastroepiploic arch


Lesser
sac
O


P
p'


1st layer
Q


Suction
tube
R

S. The middle hemostatic sutures on the anterior cut margins of the jejunum and stomach respectively are left long for traction, and the second posterior layer of interrupted sutures of silk (0000) are inserted. No complications have ensued from the use of silk sutures for the mucosal layer. In fact, this method of suture is preferred to the use of a continuous interlocking suture of fine chromic (00) catgut.

T. The closure of the second posterior layer is completed with a wide approximation of the adjacent posterior serosal surfaces.

U. The first anterior layer of silk sutures (0000) are inserted. The sutures at either angle are inserted from the "inside out" to the "outside in" and are tied as oblique traction is maintained on the angle sutures of the second posterior layer. This type of suture produces an inversion of the serosal surfaces with the suture knot on the inside of the lumen.

U. Inset to show the use of interrupted inversion sutures throughout for the closure of the first anterior layer.

V. The closure of the first anterior layer with single through and through interrupted silk sutures is completed and the insertion of the second anterior layer of interrupted seromuscular sutures (Lembert) of fine silk (0000) is begun.

W. The antecolic, isoperistaltic gastrojejunostomy along the most dependent portion of the greater curvature of the stomach is completed.

X, Y. The commencement of the wound closure using interrupted sutures of silk (00) for the peritoneum is shown. If preferred, interrupted silk sutures of the mattress variety or a continuous chromic catgut (00) suture that is doubled, may be used. The fascia and skin layers are closed with interrupted sutures of 00 and 000 silk respectively.

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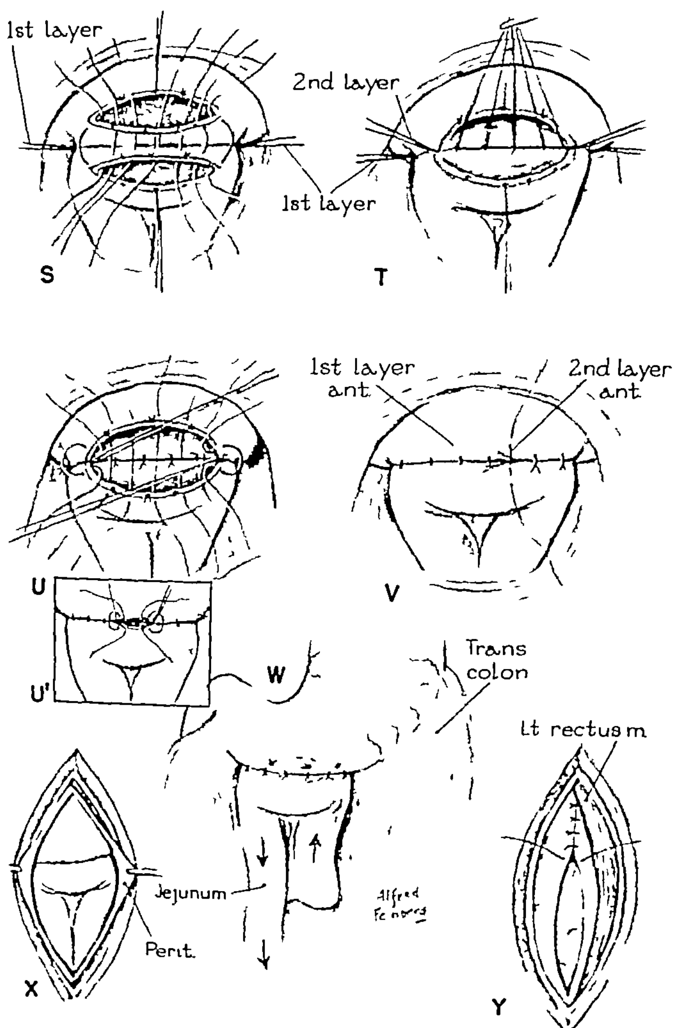
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1st layer
S
2nd layer
1st layer
T
1st layer
ant.
2nd layer
ant.
U
U'
V
W
Trans
colon
Lt rectus m.
Jejunum
Perit.
X
Y
Alfred
Feinberg

PARTIAL GASTRECTOMY WITH END TO END GASTRODUODENOSTOMY (BILLROTH I)

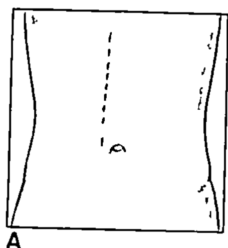
A, B C. The peritoneal cavity is entered through a right paramedian muscle-retracting (lateral) incision. Whenever concomitant severance of the vagus nerves is contemplated, and in gastric resections performed for carcinoma of the stomach, a left paramedian muscle retracting incision is preferred.

D The ascending colon is mobilized and the hepatic flexure is freed by incising the right phrenocolic ligament as indicated by the dotted line.

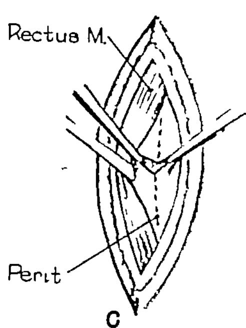
E. The ascending colon and the hepatic flexure are displaced downward and to the left to expose the retrocolic portion of the duodenum The gallbladder and the common bile duct are also visible. The curvilinear dotted line indicates the site of the incision (Kocher) which is made in the posterior parietal peritoneum for the mobilization of the duodenum and the head of the pancreas.

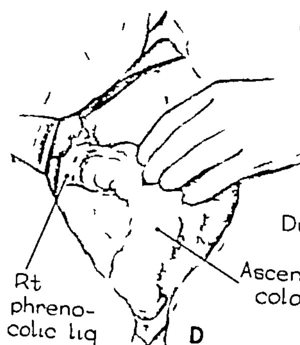
F The mobilized segment of the duodenum is displaced upward and to the left to show the inferior vena cava and its tributary the spermatic (or ovarian) vein. The lymph node lateral to the distal portion of the common bile duct and posterior to the first part of the duodenum is a constant anatomic finding. The terminal portion of the common bile duct is located between this node laterally and the gastroduodenal artery medially which are the anatomic landmarks emphasized by Cattell for the identification of the distal portion of a previously severed bile duct

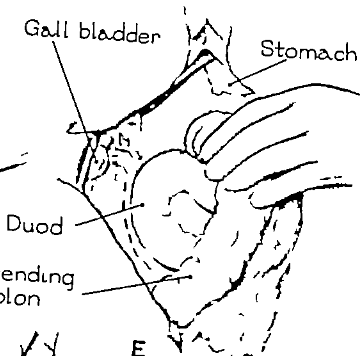
DISCUSSION—DR S. ARTHUR LOCALIO The mobilization of the duodenum is of critical importance in the performance of an end-to-end gastroduodenostomy after an adequate partial gastrectomy However we have not found it necessary to mobilize the hepatic flexure of the colon as illustrated by the author The peritoneum lateral to the duodenum from the foramen of Winslow to the superior mesenteric vessels may be readily incised and the duodenum elevated from the inferior vena cava Exposure of the common duct is done from the cystic duct down to the point at which the common duct passes behind the lateral sweep of the duodenum. If the duodenum is rolled medialward, the duct will be seen to enter the pancreatic head and disappear from view well protected by the pancreas, until it enters the ampulla about three inches from the pylorus on the posteromedial wall of the duodenum. The knowledge of these anatomic relations is important for the safe mobilization of the duodenum from its surrounding attachments

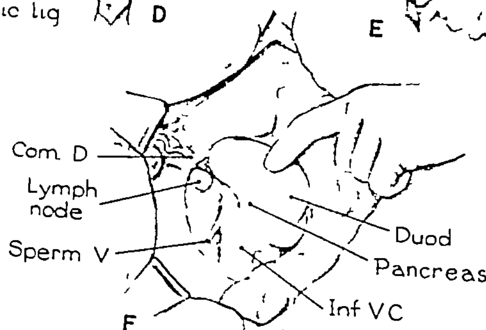

A


B


Rectus M.
Perit
C


Rt
phreno-
colic lig
D


Gall bladder
Stomach
Duod
Ascending
colon
E


Com. D
Lymph
node
Sperm V
Duod
Pancreas
Inf VC
F

G H. By blunt dissection with a clamp an opening is made in the relatively avascular gastrohepatic ligament (G) through which the left index and middle fingers of the surgeon are inserted into the lesser sac. By blunt digital dissection in the lesser sac the posterior wall of the stomach is separated from the often adherent transverse mesocolon, and the index finger is seen to protrude through an opening in an avascular area of the gastrocolic ligament (H). This method of entrance into the lesser sac is preferred to the approach through the gastrocolic ligament because it is believed to lessen the possibility of injury to the middle colic artery with resulting segmental compromise of the circulation to the transverse colon.

I. The greater curvature of the stomach is mobilized by serially clamping and severing the gastrocolic ligament.

J J′. The stomach is encircled by a catheter (No. 14 F) through which it is elevated by upward traction to expose the pancreas and the thin fibroareolar adhesions between the anterior surface of this organ and the stomach (J). Just beneath the *inferior border of the pylorodoudenal junction*, the gastroduodenal artery and its two branches, the superior pancreaticoduodenal and the right gastroepiploic arteries, may be seen. This is represented diagrammatically in J′.

The short solid black line just distal to the bifurcation of the gastroduodenal artery (J′) indicates the site of severance of its superior pancreaticoduodenal branch.

K. By traction through the catheter the stomach is displaced downward, and through an opening in the gastrohepatic ligament, the right gastric artery and the branch from it to the duodenum are clamped preliminary to being severed and ligated.

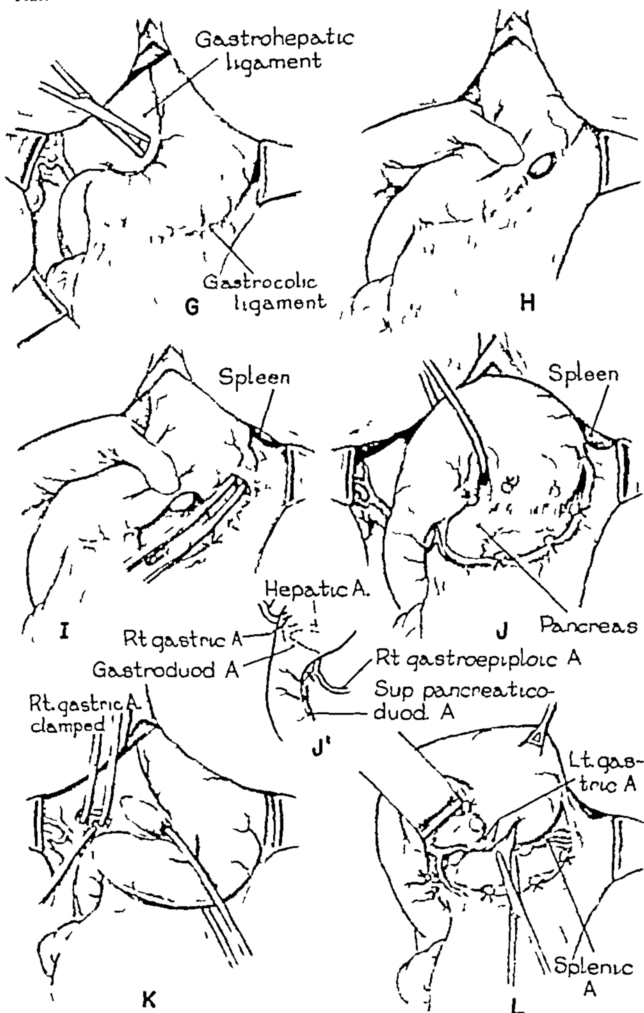
L. The stomach is rotated upward and retracted *cephalad*, and the fibrous tissue attachments of the gastric ulcer on the posterior wall of the stomach to the anterior surface and superior border of the pancreas are being severed by scissor dissection. In this particular patient two left gastric arterial branches arising separately from the celiac axis were present as depicted. The arch formed by the bifurcation of the hepatic artery into its hepatic propria and gastroduodenal branches is clearly illustrated. This arch is an important landmark for the identification of the portal vein which passes obliquely upward beneath the arch and is covered by fatty areolar tissue. A large lymph node overlying the hepatic artery in the region of its bifurcation is a constant anatomic finding. The splenic artery and the ligated and severed ends of the superior pancreaticoduodenal artery are also visible.

Discussion—Dr. Localio (cont.)

In mobilizing the greater curvature of the stomach, the clear area devoid of blood vessels between the left gastroepiploic artery and the first short gastric vessel is an important landmark because it is the point of proximal transection of the stomach in the performance of a 65 to 75 per cent gastric resection. One or two of the short gastric vessels are severed to permit the mobilization of the proximal portion of the greater curvature of the stomach.

On the lesser curvature side of the stomach an attempt should be made to ligate the left gastric artery in its course across the dome of the lesser sac before it has divided into ascending and descending branches. The existence of two left gastric arteries, as illustrated (N′), is an unusual anomaly.

A method, which can be used as an alternate to that depicted (Plate 98, N, Q) in handling the lesser curvature, is believed of value particularly in the pa-


Gastrohepatic ligament
Gastrocolic ligament
G
H
Spleen
Spleen
I
J
Pancreas
Hepatic A.
Rt gastric A
Gastroduod A
Rt gastroepiploic A
Sup pancreatico-duod. A
J'
Rt. gastric A. clamped
Lt. gastric A
K
L
Splenic A

G H. By blunt dissection with a clamp, an opening is made in the relatively avascular gastrohepatic ligament (G) through which the left index and middle fingers of the surgeon are inserted into the lesser sac. By blunt digital dissection in the lesser sac the posterior wall of the stomach is separated from the often adherent transverse mesocolon, and the index finger is seen to protrude through an opening in an avascular area of the gastrocolic ligament (H) This method of entrance into the lesser sac is preferred to the approach through the gastrocolic ligament because it is believed to lessen the possibility of injury to the middle colic artery with resulting segmental compromise of the circulation to the transverse colon.

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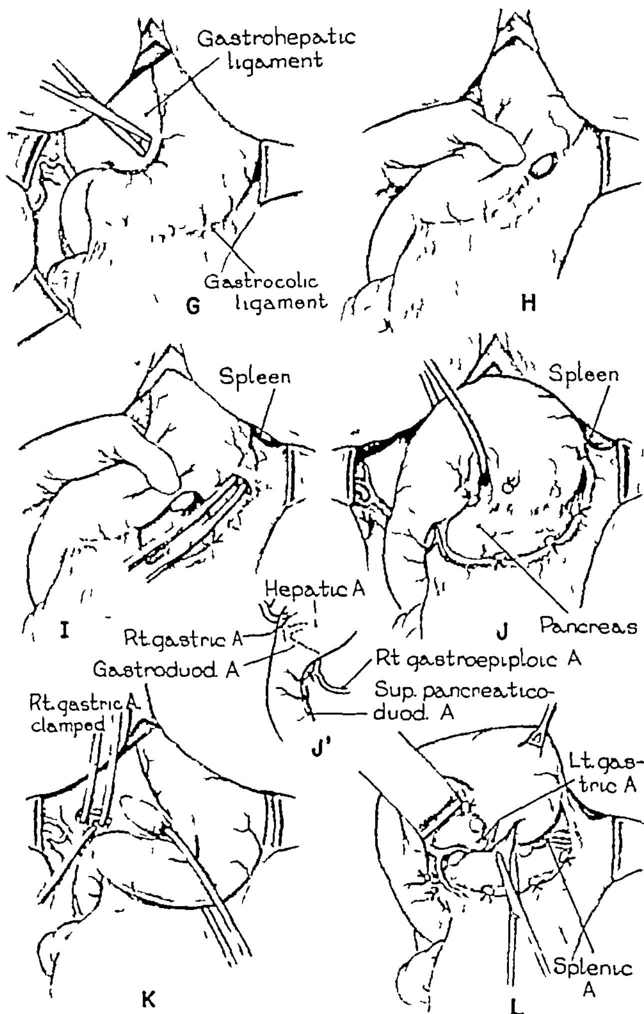
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On the lesser cu[illegible]
tempt should be m[illegible]
tery in its course a[illegible]
before it has divided [illegible]
branches The existen[illegible]
as illustrated (N′), is an

A method, which can [illegible]
that depicted (Plate 98 [illegible]
curvature, is believed of valu[illegible]


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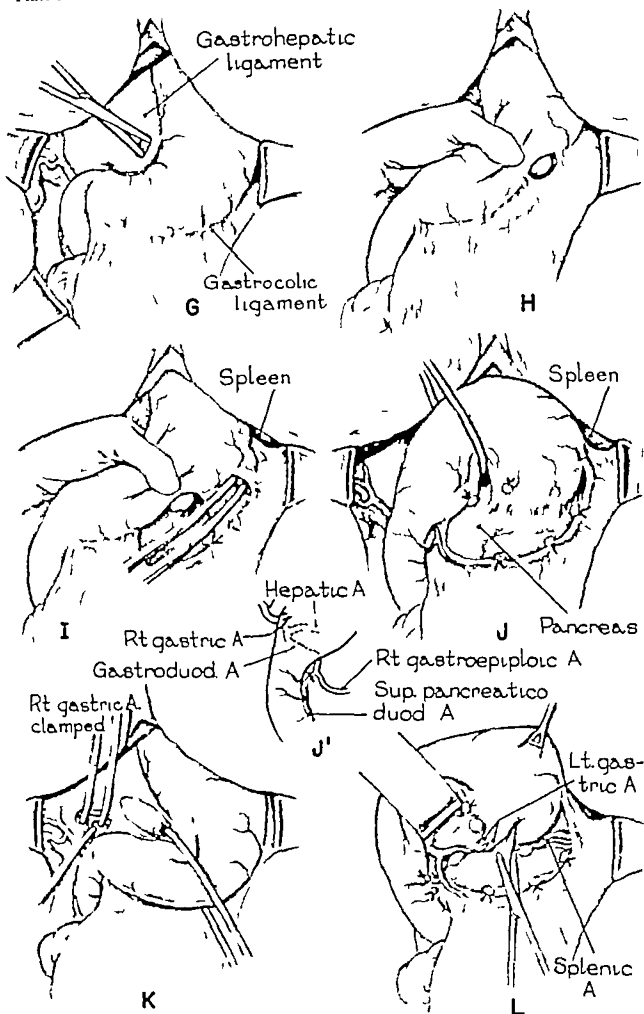
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Sup. pancreatico duod A
J'
Rt gastric A. clamped
K
Lt. gastric A
Splenic A
L

M. The pyloroduodenal region of the stomach is cross-clamped with a small Payr clamp and two Babcock clamps are used to immobilize the duodenum as its anterior wall is transected with a scalpel. To avoid unnecessary tissue trauma the distal transected end of the duodenum is not cross-clamped.

M Inset to show the transection of the posterior wall of the duodenum with scissors rather than a scalpel. To prevent cutting the posterior wall shorter than the anterior the scissors are inclined upward toward the stomach as the transection is continued.

N. The lumen of the distal transected end of the duodenum is occluded temporarily with Babcock clamps and the proximal cross-clamped end is covered by a moist gauze pad and reflected upward toward the patient's left shoulder This upward displacement of the distal portion of the stomach exposes the gastropancreatic fold of peritoneum which contains the left gastric vessels. An opening is made in this fold and one of the two left gastric arteries previously mentioned is shown elevated on a clamp The relation of the ulcer on the posterior wall of the stomach to this vessel is visible

N Inset showing the uppermost of the two left gastric arteries being doubly clamped distal to the previously applied ligature (00 silk). Either the triple clamp method or the preliminary ligature and two clamp method as illustrated is used routinely for the severance of the left gastric artery

O The proximal portion of the lesser curvature of the stomach is cleared in preparation for the subsequent anastomosis to the duodenum by the resection of segments of the ascending and descending branches of the left gastric artery

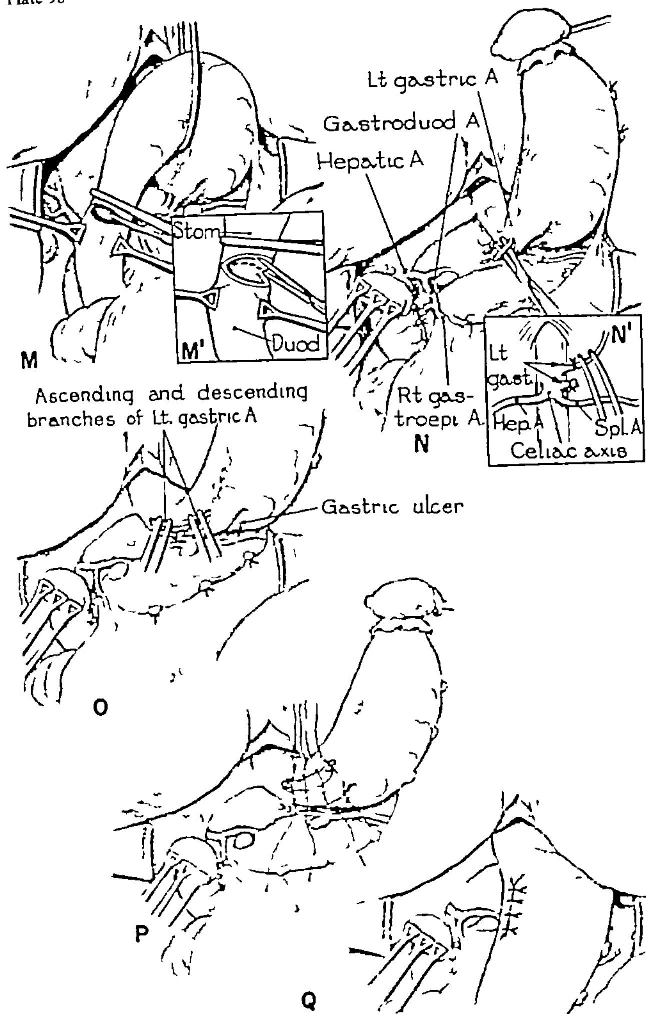
P Q The resulting "bare" area of the lesser curvature is reperitonized by interrupted seromuscular sutures (Lembert) of silk (000) which are first all inserted (P) and then tied (Q)

Discussion—Dr. Localio (cont.)

tient with a high lying lesser curvature ulcer In the use of this alternate method, Kocher clamps are applied to the greater curvature of the stomach in the bare area above the entrance of the left gastroepiploic artery The width of the bite of the Kocher clamp should approximate the width of the duodenum so that there will be a minimum of disparity in diameter between the transected ends of the stomach and duodenum at the site of anastomosis. The gastric incision is now carried cephalad across the anterior and posterior walls of the stomach to a point on the lesser curvature one to two cm. below the esophagus. This maneuver permits the resection of a high-lying lesser curvature ulcer It also adds to the mobility of the remaining gastric pouch and tubes the stomach, making the gastroduodenostomy a simpler anastomosis. In the performance of this particular step in technic, the Von Petz clamp is of value.

In the performance of the anastomosis (Plate 100, V–X"), the surgeon must use care in closing the lesser curvature corner at its point of junction with the duodenum. This angle is best sealed by a simple seromuscular purse string suture that includes the anterior and posterior walls of the stomach and the duodenum.

Plate 98


Stom
Duod
M'
M
Lt gastric A
Gastroduod A
Hepatic A
Lt
gast.
N'
Hep.A
Spl.A
Celiac axis
Rt gas-
troepi A.
N
Ascending and descending
branches of Lt. gastric A
Gastric ulcer
O
P
Q

R. Further mobilization of the proximal portion of the greater curvature of the stomach is obtained by serially clamping and severing the gastrosplenic ligament which contains the vasa brevia.

S. Guy sutures of silk (000) are inserted at opposite sites on the lesser and greater curvatures just proximal to the site of election for transection of the stomach. The stomach is then cross-clamped distally with a large Payr clamp An incision is made through the seromuscular layer of the proximal portion of the stomach anteriorly and the vessels in the submucosal layer are undersewn with suture ligatures of silk (000).

T The stomach is displaced upward, and similarly an incision is made through the seromuscular layer of the proximal portion of the stomach posteriorly and the underlying vessels are undersewn with suture ligatures of 000 silk. The ulcer on the posterior gastric wall is now clearly visible.

U The stomach is reflected downward, and the incision through the submucosal and mucosal layers anteriorly is being made with a scalpel. Similarly this incision will be continued posteriorly to complete the partial resection of the stomach. It may be observed that to avoid crushing trauma to the tissues, no clamps are applied to the proximal segment of the stomach which will be anastomosed to the duodenum

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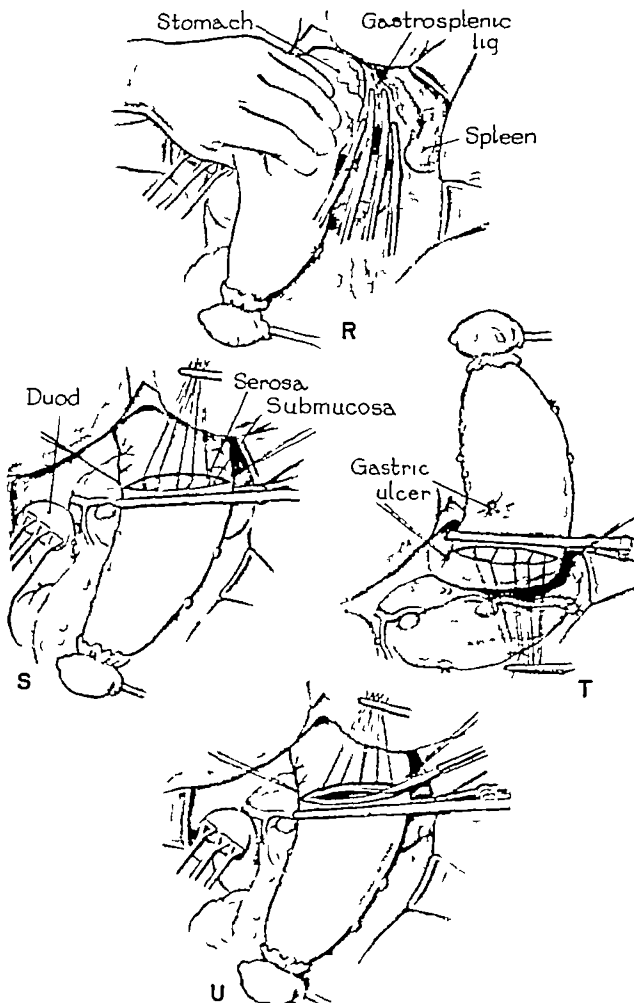
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Stomach
Gastrosplenic lig
Spleen
R
Duod
Serosa
Submucosa
S
Gastric ulcer
T
U

V The lumen of the proximal gastric pouch is diminished by partial closure on the lesser curvature side using inversion sutures of interrupted silk (000) These sutures are inserted from the "inside out" on one side and from the "outside in" on the other so that, when tied, the knots are on the inside of the lumen

V' A second layer of inversion is obtained with a series of interrupted seromuscular mattress sutures (Halsted) of silk (000).

V The sutures forming the first posterior layer of the anastomosis, a series of interrupted mattress sutures of silk (000), are first all inserted before being tied.

W W W The first posterior layer of mattress sutures is tied. Through and through sutures (0000) which include all the layers of the stomach and duodenum and form the second posterior layer are being inserted. The insertion of the second posterior layer is completed (W'), and the first layer anteriorly is begun by the insertion of a coapting W-shaped mattress suture on the lesser curvature "angle" of the anastomosis (W").

X. Subsequently the sutures which form the first anterior layer are inserted alternately from either end toward the center Each suture is inserted from the "inside out" to the "outside in" so that, when tied, the knots are on the inside of the lumen and the anterior layers of the stomach and duodenum are inverted.

X X A through and through interrupted figure of 8 mattress suture of silk (000) is inserted in the midline about the two terminal anterior inversion sutures and, when tied, the first anterior layer of the anastomosis is completed (X"). The interrupted seromuscular mattress sutures (000 silk) forming the second anterior layer of the anastomosis are all first inserted before being tied to complete the end to-end gastroduodenostomy

Y The end to-end gastroduodenostomy is completed, and its relation to the surrounding structures is visible. A drain is not employed.

Z. The anterior parietal peritoneal layer is being closed with a continuous interlocking double strand suture of 00 chromic catgut.

Z The fascial layer is approximated with interrupted sutures of silk (00) and the skin is being closed with interrupted sutures of 000 silk threaded on straight milliner or Cambric needles These needles are all first inserted, withdrawn individually and the sutures tied.

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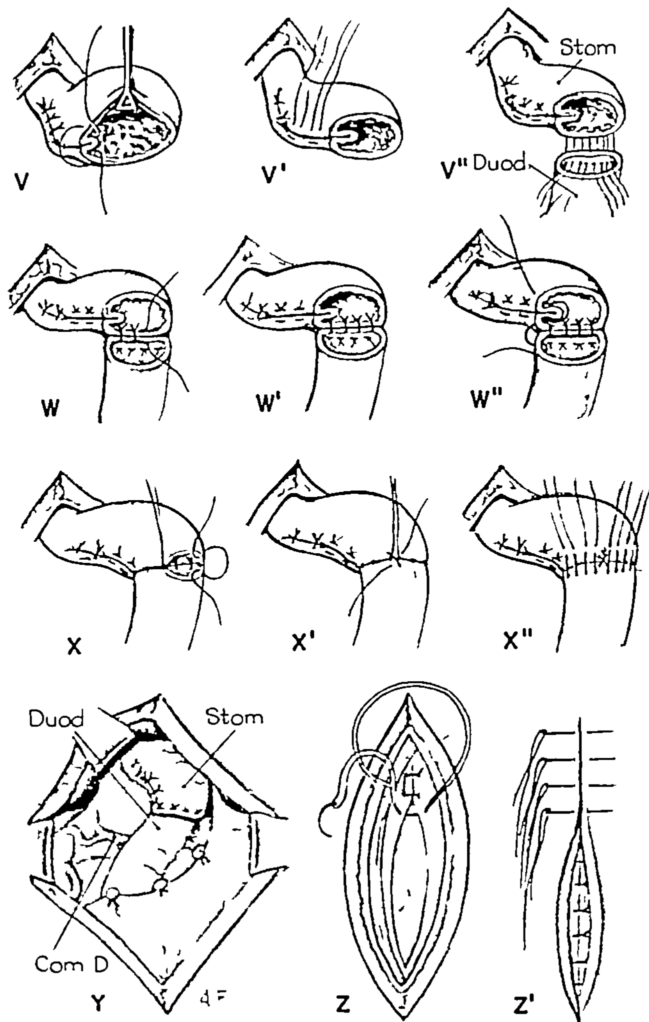
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Plate 100



PARTIAL GASTRECTOMY FOR STOMAL (MARGINAL) ULCER WITH SEGMENTAL ENTERECTOMY JEJUNOJEJUNOSTOMY AND GASTROJEJUNOSTOMY (BILLROTH II)

This patient, a 64-year-old white man, was admitted to the hospital because of acute massive gastrointestinal bleeding. Three and-one half years previously an infradiaphragmatic partial resection of the vagus nerves and an antecolic gastrojejunostomy along the most dependent portion of the greater curvature of the stomach in close proximity to the pyloroduodenal junction was done The indication for operation was intractable pain. At the time of operation an active chronic duodenal ulcer with extensive edema of the surrounding tissues was observed. The postoperative course was entirely satisfactory until the present admission to the hospital because of the bleeding episode. The bleeding was controlled under conservative management, and ten days following the initial hemorrhage, operation was performed as depicted in the illustrations.

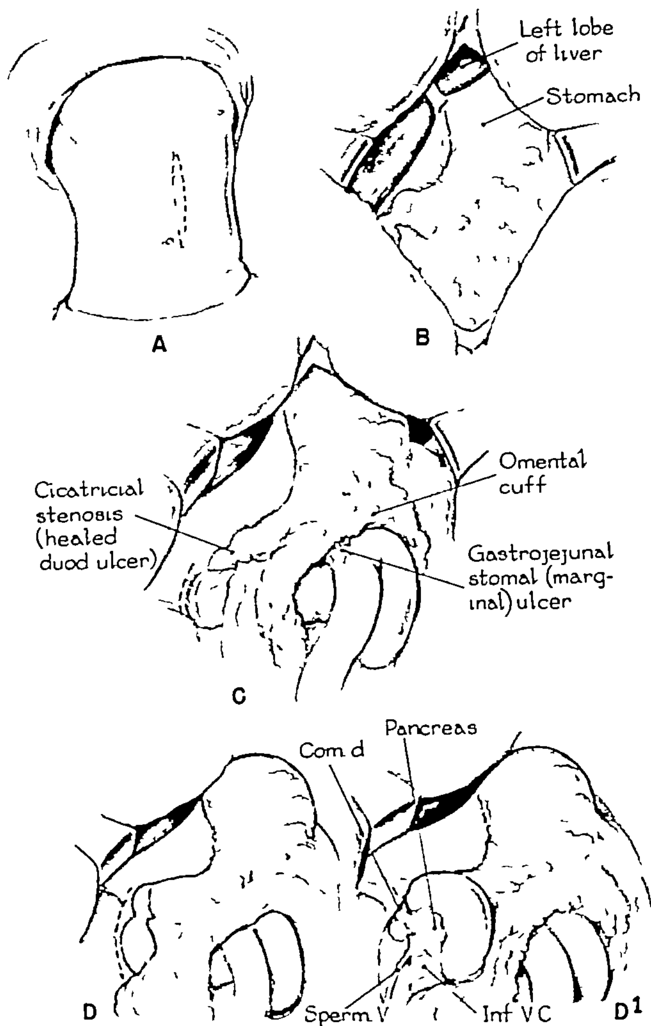
A B. The previous operative scar is excised in an elliptical manner (A), and the peritoneal cavity is entered (B)

C. The omental cuff is elevated and the cicatrix, indicative of the location of the marginal or stomal ulcer at the juncture of the stomach and efferent loop of jejunum, is visible The extensive inflammatory reaction that was observed at the primary operation in the area surrounding the duodenal ulcer is absent. In the process of healing, a cicatrix formed which caused a constriction of the lumen of the duodenum between its first and second portion. The dotted line indicates the site of severance of the right phrenocolic ligament preparatory to mobilizing the hepatic flexure of the colon.

D The hepatic flexure is displaced downward, and the line of the incision (Kocher) in the posterior parietal peritoneum prior to mobilizing the duodenum is depicted in dotted outline

D[1] The retrocolic segment of the duodenum and the head of the pancreas are rotated (Moynihan rotation maneuver) toward the midline, and the related subjacent structures are depicted

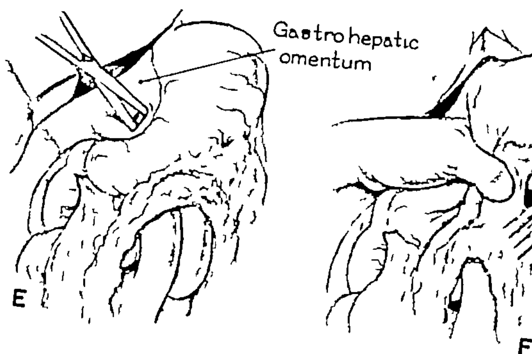
Plate 101

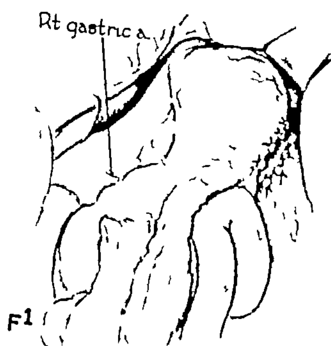

Left lobe of liver
Stomach
A
B
Omental cuff
Cicatricial stenosis (healed duod ulcer)
Gastrojejunal stomal (marginal) ulcer
C
Pancreas
Com d
D
Sperm V
Inf V C
D1

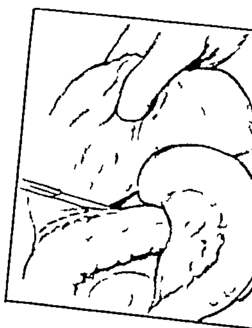
E, F An opening is made by blunt dissection in the relatively avascular area of the gastrohepatic ligament (E) The index and middle fingers of the left hand of the surgeon are inserted through this opening into the lesser sac, and, by blunt dissection within the sac, the adherent transverse mesocolon is separated from the posterior wall of the stomach. The blunt dissection is continued until the fingers are finally protruded through an opening in an avascular portion of the gastrocolic ligament along the greater curvature of the stomach (F) The gastrocolic ligament is serially clamped and severed (dotted line) to mobilize partially the proximal portion of the greater curvature of the stomach (F)

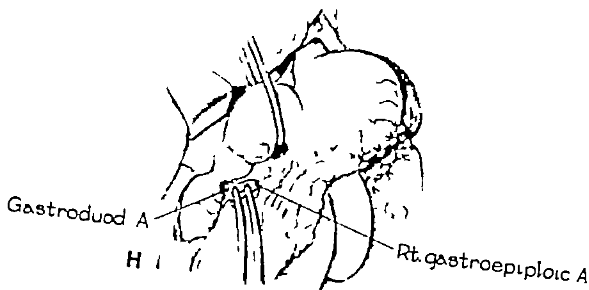
F[1] G The partial mobilization of the greater curvature of the stomach proximally is completed (F) The inset (G) shows an alternate method for entrance into the lesser sac in mobilizing the distal portion of the greater curvature of the stomach. Instead of severance of the gastrocolic ligament, the relatively avascular line of attachment of the greater omentum to the transverse colon is severed with a scalpel, as depicted.

H Traction is applied to a piece of rubber tissue tape encircling the antral region of the stomach, and the right gastroepiploic artery just distal to its site of origin from the gastroduodenal artery is doubly clamped before being severed and ligated (000 silk)


Gastrohepatic
omentum
E
F


Rt gastric a.
F1




Gastroduod A
Rt. gastroepiploic A
H

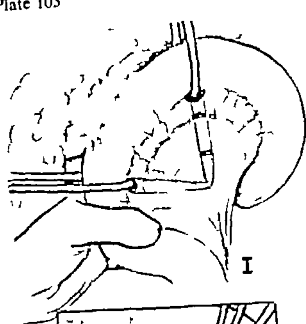
I. The sites of election for transection of the afferent and efferent limbs of the jejunum are encircled by catheters (12 F) and direction lines for severance of the mesentery are made through its serosal covering.

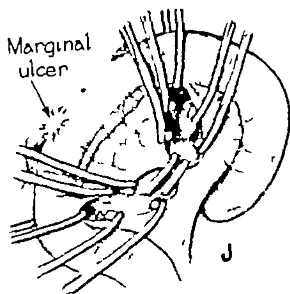
J J^1 The remaining mesenteric attachment of the segment of bowel which is being resected is doubly clamped preparatory to severance (J) The clamps on the mesenteric side of the segment of jejunum that is removed are replaced with ligatures of silk (000) while those on the opposing mesentery are replaced with hemostatic suture ligatures of 000 silk (J) The jejunum is doubly cross-clamped at the sites of election for transection of the afferent and efferent limbs of the jejunum (J).

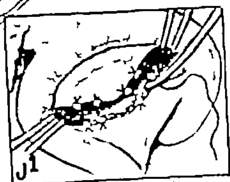
K The transected ends of the segment of jejunum that is resected are covered with pieces of rubber dam and occluded with heavy ligatures (No 1) of silk The remaining transected ends of the jejunum are held in clamps ready to be approximated for the performance of a closed or "aseptic" end to-end anastomosis

K^1 K^2 The handles of the clamps are held downward (caudad) and a series of interrupted seromuscular mattress sutures of silk (000) are inserted but not tied (K) The handles of the clamps are next rotated upward (cephalad) and in like manner a second series of interrupted seromuscular mattress sutures are inserted on the opposite side of the bowel (K).

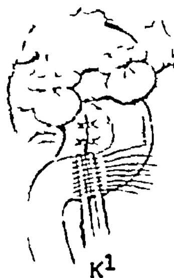
Plate 103

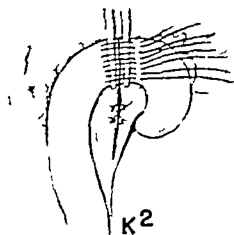












K[3] The strands of the untied seromuscular mattress sutures are held between the thumb and index finger of each hand of the surgeon, and traction is applied as the first assistant removes slowly the clamps from the transected ends of the jejunum.

K[4] The mattress sutures are tied and cut with the exception of the two sutures which are immediately adjacent to either side of the mesentery The opening remaining on the antimesenteric wall of the bowel following the removal of the clamps is to be closed with a mattress suture of 000 silk which is inserted but not tied.

K[5] The strands of the sutures adjacent to the mesenteric sides of the bowel wall are used to rotate partially the bowel and expose the opening at its mesenteric border which is occluded when the mattress suture previously inserted is tied The insertion of this suture though most important, is rarely shown in illustrations depicting the closed or "aseptic" technic for bowel resection.

K[6] Upon completion of the anastomosis digital invagination of the bowel wall on either side of the anastomotic line is done to insure patency of the stoma. This particular step in technic cannot be overemphasized, as one of the technical hazards in this operation is the formation of a diaphragmatic occlusion of the bowel lumen. The cut margins of the mesentery are approximated with interrupted sutures of 000 silk.

L. Upon completion of the small bowel resection and anastomosis, the pyloroduodenal region of the stomach is mobilized by doubly clamping and severing the right gastric artery which is isolated through an opening made by blunt dissection in the gastrohepatic ligament

M. The pyloroduodenal region is completely mobilized and the most distal portion of the pylorus is cross-clamped with a crushing (Payr) clamp The duodenum is not cross-clamped Instead it is secured with guy sutures of silk (000) A scalpel is used for the transection of the anterior wall of the duodenum immediately distal to the pyloric vein (vein of Mayo) as depicted. The constriction of the duodenum caused by the healed duodenal ulcer is readily visible. The location of this constriction, between the first and second portions of the foreshortened duodenum is in close approximation to the entrance of the common bile duct.

M[1] Inset to show the transection of the anterior wall of the duodenum completed and its posterior wall being severed with scissors. The scissors are inclined upward on the posterior wall to assure an adequate length.

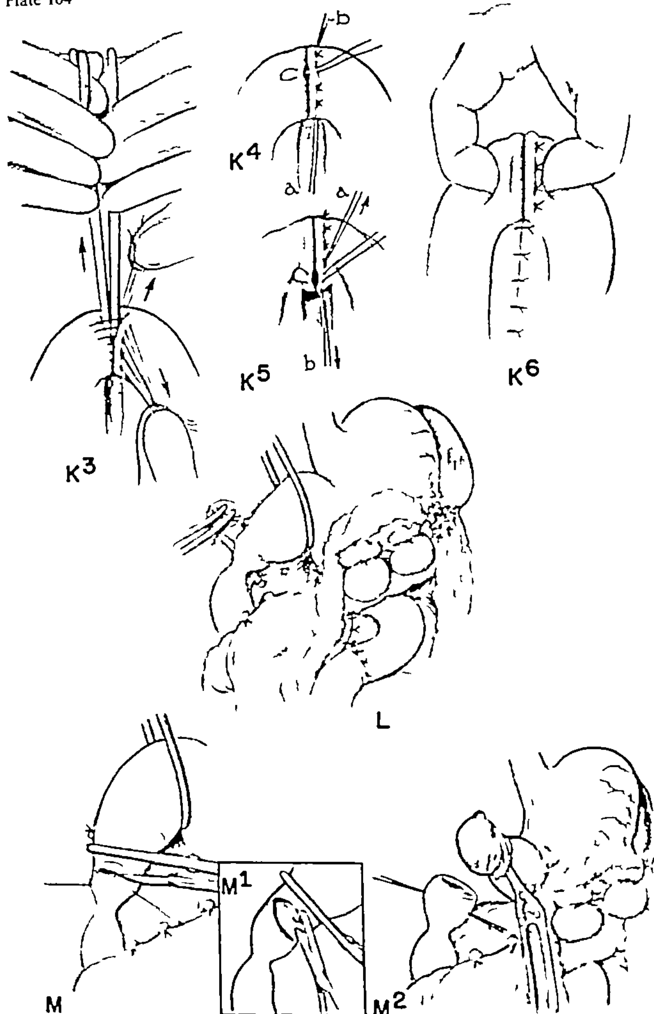
M[2] The transection of the duodenum is completed and its proximal cut end is covered with a thick moist gauze pad. Digital exploration of the lumen of the duodenum distally showed adequate patency at the site of constriction. Accordingly closure of the duodenal stump proximally was believed feasible.

DISCUSSION—DR. S ARTHUR LOCALIO. In patients, as illustrated, with a gastroenteric stomal ulcer we have found it expedient to transect and reconstruct the jejunum as illustrated in Plates 103 and 104 I K as the first step of the operation. The operation can now proceed as a routine gastrectomy for duodenal ulcer

The operation for a callus-penetrating duodenal ulcer presents its technical difficulties and dangers during the mobilization of the duodenum. By first transecting the stomach at the proximal line of resection, the lesser sac is widely opened, and the duodenum and the ulcer can be approached from several directions We have used the greater curvature clear area between the left gastroepiploic artery and the lowest short gastric artery as the proximal line of transection in order to perform a 65 to 75 per cent resection.

With the stomach transected, the duodenum and pancreas are mobilized and the common duct exposed The surgeon can now safely proceed to dissect the duodenum and ulcer from the pancreas and to mobilize a sufficient length of normal duodenum beyond the ulcer to effect a secure closure of the duodenal stump This is accomplished by using the common duct as a reference point and dissecting the ulcer from whichever direction it appears to proceed easily At times it is valuable to make an incision in

Plate 104



N N[1] N[2] The duodenal stump is closed with interrupted sutures of silk (000) The sutures are inserted from the "inside out" to the "outside in" so that, when tied, the tissues are inverted and the knots are on the inside of the lumen (N) The sutures are inserted alternately from either end and terminate in the center of the line of closure (N) The two terminal sutures are encircled by a figure of 8 mattress suture (N) following which the terminal sutures are cut and the reinforcing mattress suture is tied (N[2]) A serosal layer of interrupted seromuscular sutures is used for the closure of the duodenal stump This suture layer is begun at either angle by the insertion of half purse string seromuscular sutures (N) When these sutures are tied the angles are inverted and "dog ears" are avoided.

N[3] N[4] Insets to show the completion of the second layer of the closure by the insertion of a series of seromuscular Halsted mattress sutures These sutures are all first inserted (N[3]) and then tied (N).

O The closure of the duodenal stump is further reinforced by impingement against the serosal covering overlying the pancreas (posterior wall of lesser sac) with interrupted sutures of silk (000) The anchorage of the lesser curvature of the stomach by the gastropancreatic fold of peritoneum and the contained left gastric vessels is visible.

P An opening is made in the gastropancreatic fold of peritoneum, and the exposed left gastric vessels are triply clamped and severed between the two distal clamps (solid black line).

P[1] Inset to show the occlusion of the proximal cut end of the left gastric artery by a ligature and a suture ligature respectively to replace the previously applied clamps. The bifurcation of the distal end of the severed left gastric artery into ascending and descending branches on the lesser curvature of the stomach is visible.

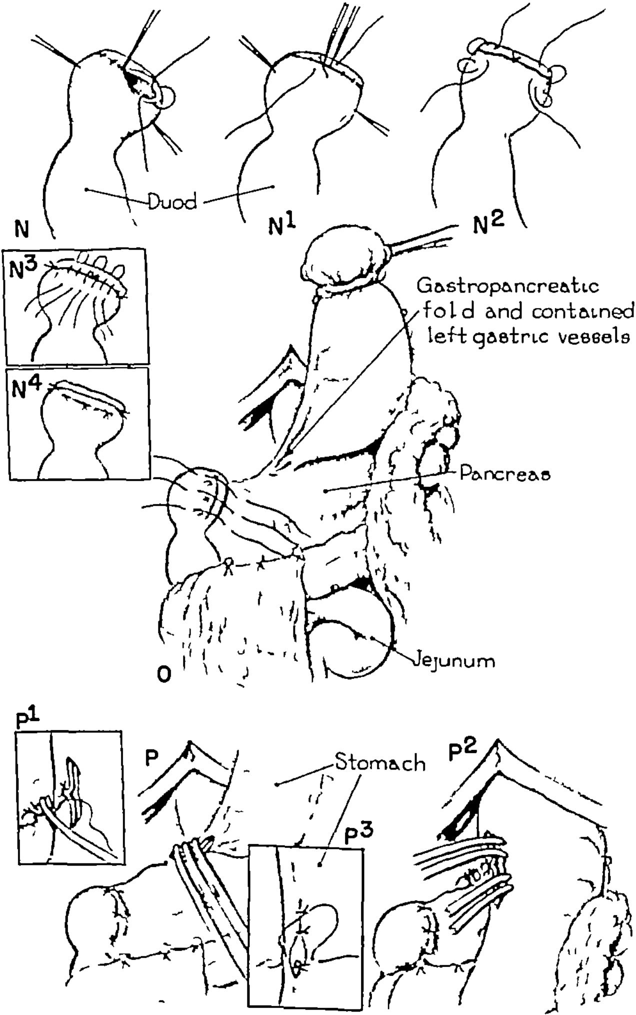
P[2] P[3] The ascending and descending branches of the left gastric vessels are doubly clamped (P[2]) Following the severance of the vessels between clamps, the intervening segment is removed to clear the proximal portion of the lesser curvature of the stomach The "bare" area is reperitonized with interrupted Lembert sutures of 000 silk (P[3])

Discussion—Dr. Localio (cont.)

the anterior duodenal wall close to the pylorus. The index finger of the left hand inserted into the duodenum will aid in following the contortions made by a chronic ulcer This dissection is at times associated with very little bleeding because of the paucity of blood vessels in the fibrous tissue The bed of the ulcer in the pancreatic head is not removed. The ulcer consists merely of a rim of duodenum The vast percentage of duodenal ulcers occur in the first 2 5 cm of duodenum and must therefore be removed if complete antrectomy is to be performed and a secure closure of the duodenal stump effected.

The ease of exposure of the common duct and the protection that it receives in its course in the pancreatic head can protect this structure from injury In our experience the accessory pancreatic duct has been more vulnerable. If this duct is transected it can be ligated with a purse-string suture of 00000 arterial silk. A sump or other suitable drain should be placed down to the pancreatic head for six to seven days in the event that subsequent leakage from the ligated duct should occur

The final gastrojejunostomy may be performed, antecolic or retrocolic, antiperistaltic or isoperistaltic, and to the whole of or to a portion of the proximal cut end of the stomach The main factors of importance are an adequate resection, the complete removal of the antrum, and the use of a short jejunal loop.



Duod
N
N1
N2
N3
N4
Gastropancreatic fold and contained left gastric vessels
Pancreas
Jejunum
O
p1
P
Stomach
P2
p3

Q The stomach is cross-clamped with a large Payr clamp just below the site of election for its transection and then reflected upward and to the left to demonstrate the insertion of the first posterior layer of the side-to-side antecolic gastrojejunostomy (Reichel–Polya) This layer consists of interrupted 000 silk sutures which approximates the proximal (afferent) limb of jejunum to the lesser curvature and the distal (efferent) limb to the greater curvature of the stomach.

Q[1] An incision is made through the seromuscular layer of the jejunum, and the vessels in the submucosal layer are undersewn with suture ligatures of silk (0000). The incision to be made through the seromuscular layer of the posterior wall of the stomach is indicated by the dotted line.

Q[2] The insertion of the hemostatic suture ligatures is completed. Only one line of such sutures is required on the gastric side as the clamp distally prevents retrograde bleeding.

Q[3] The opening previously made into the lumen of the stomach with a scalpel is enlarged by scissor dissection. In like manner an opening was previously made in the jejunal segment and covered with a warm moist pad.

R. The stomach is turned downward and an incision is being made through the seromuscular layer anteriorly to expose the vessels in the submucosa.

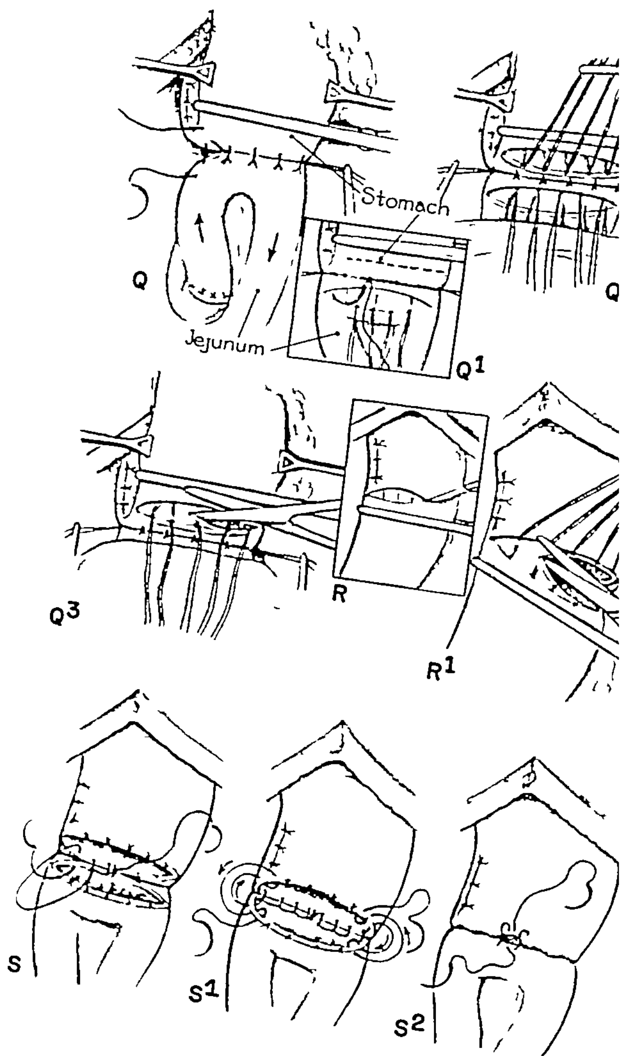
R[1] A row of hemostatic suture ligatures of silk are inserted proximally and the transection of the stomach anteriorly is being completed by scissor dissection.

S. A partial gastrectomy (70 per cent) is completed and the second posterior layer of the anastomosis is being inserted. This consists of a continuous interlocking suture of 00 chromic catgut swedged on minimum trauma needles at either end. The suture starts in the midline posteriorly and continues to the right with one needle and then to the left with the other This particular technic avoids terminating the closure at the angles of the anastomosis. Interrupted through and through sutures of silk (000) may be used, and generally this is the preferred method

S[1] S[2] The sutures "turn the angles" as depicted (S) and continue from either end toward the center as inverting (Connell, "loop on the mucosa") sutures which form the first anterior layer (S[2])

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Stomach
Jejunum
Q
Q1
Q
Q3
R
R1
S
S1
S2

S3 *The needle of the suture which terminates* in the center on the gastric side is inserted into the lumen of the jejunum and out *through its anterior wall Conversely* the needle of the suture which terminates in the center of the jejunal side is inserted into the *lumen of the stomach and out through its* anterior wall. When tied, these sutures complete the closure of the first layer anteriorly

S4 The second anterior layer a series of interrupted 0000 silk sutures is inserted, and all *the sutures are tied with the exception* of the suture inserted for the closure of the "angle of leakage." This suture, a modified pursestring, includes a "*bite*" *in the anterior* and posterior walls of the stomach at the "angle" of the anastomosis on the lesser *curvature* and *abuts the afferent limb of the* jejunum into the "angle" to reinforce the closure.

T This is a view of the operative field following the completion of the operation closed and "buried" duodenal stump, the end to-end anastomosis of the jejunum, and the end-to-side antecolic gastrojejunostomy (Reichel–Polya) are visible.

U The artist s sketch of the *operative specimen* after it was opened along the wall of the jejunum opposite the stoma is shown. The ulcer is located on *the margin of the anastomosis* at its efferent end. Approximately two thirds of the ulcer projected onto the jejunal side and one third onto *the gastric side of* the stoma

V W The wound is closed according to the technic described by the late T E. Jones of Cleveland, using interrupted sutures of 0 silk. For a paramedian muscle-retracting incision each suture is first inserted through fascia, muscle, and peritoneum on one side and then through the peritoneal and fascial layers on the other (V). The suture is then reinserted on either side through the fascial layers only (V) The completed closure is illustrated in W

X. The skin closure with interrupted sutures of 000 silk completes the operation.

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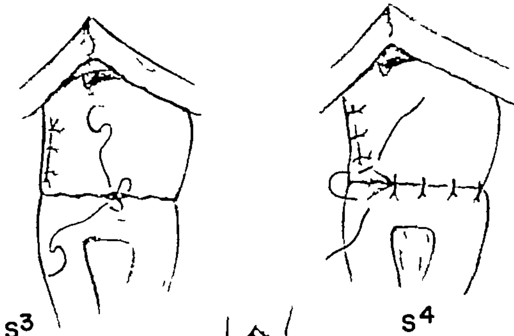
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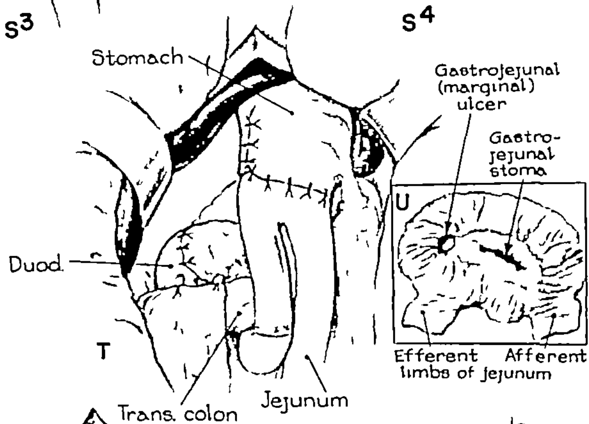
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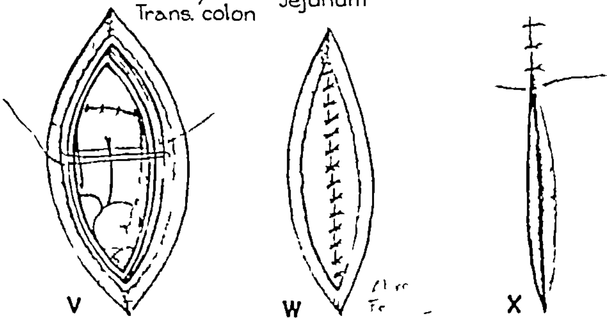
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S3
S4


Stomach
Gastrojejunal (marginal) ulcer
Gastro-jejunal stoma
U
Duod.
T
Efferent Afferent limbs of jejunum
Trans. colon
Jejunum


V
W
X

TOTAL GASTRECTOMY SPLENECTOMY AND PARTIAL PANCREATECTOMY

A. The solid black line indicates the left paramedian muscle-retracting (lateral) incision that is employed. Other types of incisions that may be preferred are in dotted outline

B, C, D The anterior rectus sheath is incised, the rectus muscle is mobilized laterally from its midline attachment, and the peritoneal cavity is entered. The blood vessels and their relation to the tendinous inscriptions are visible.

E. The left lobe of the liver is mobilized by severance of the avascular left triangular ligament.

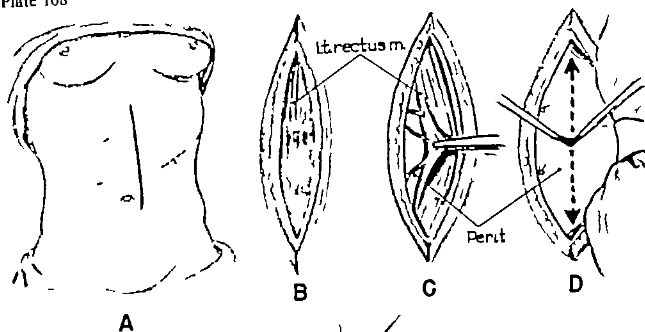
F The mobilized left lobe of the liver is turned inward on itself covered by a moist gauze pad, and retracted toward the midline The peritoneal reflection overlying the esophagocardial junction, the inferior phrenic vein, and the "bare" area of the diaphragm may be clearly seen.

G The stomach is displaced medialward to demonstrate the gastrosplenic ligament with its contained vasa brevia and the line of incision in the posterior layer of the lienorenal ligament for the mobilization of the spleen and the tail of the pancreas.

DISCUSSION—DR GEORGE T PACK. In all instances of gastric cancer the abdominal incision should be done first, thereby permitting abdominal exploration. If the cancer be inoperable, the laparotomy would be enough The surgeon may decide that it is technically feasible to do an abdominal total gastrectomy However the abdominal incision is planned so that if the exposure is better facilitated by a thoracic extension, the upper abdominal oblique or vertical epigastric incisions may be prolonged into the left thorax either intercostally or through a rib bed after excision of the rib Also the left Marwedel paracostal incision permits an inverted T prolongation into the chest

In earlier years all of our total gastrectomies were done by the abdominal route, and our patients experienced fewer pulmonary complications. In spite of the longer incision and the greater time required for wound closure, the actual resection and anastomosis can be done more quickly thereby saving total time. In many of our patients the operation has been technically easier to perform through an abdominothoracic exposure. This has been an important advantage in difficult cases, especially those of borderline operability and when the gastric cancer is situated high in the gastric cardia Gastric adenocarcinomas can and do invade the abdominal esophagus and may extend above the diaphragmatic level. Al-

Plate 108


Lt rectus m.
Perit
A
B
C
D
Lt triangular ligament
Left lobe of liver
Tumor
Stomach
E
Bare area
Inf phrenic V
Lienorenal lig (post layer)
Gastrosplenic ligament (ant. layer)
Spleen
F
G

H. The mobilization of the spleen posteriorly is completed, and the freeing of the splenic flexure of the colon by severance of the left phrenocolic ligament is shown in dotted outline. One may prefer to mobilize the spleen in a later stage of the operation be cause of the potential risk of excessive blood loss from a tear in the splenic capsule or from the raw area of the splenic bed

I. The apron of greater omentum which is removed in continuity with the tumor is freed by scalpel dissection from its relatively avascular attachment to the transverse colon.

J The hepatic flexure of the colon is mobilized by scissor dissection along the fascial fusion layer of Toldt ("white line") and the right phrenocolic ligament.

K. The right and transverse colon are retracted downward and to the left to expose the retrocolic portion of the duodenal loop and the enclosed head of the pancreas. The incision (Kocher) in the posterior parietal peritoneum preparatory to the mobilization of the duodenum and head of the pancreas is shown in dotted outline.

K[1] Through an opening in the gastrohepatic ligament, the right gastric artery is doubly clamped prior to its severance.

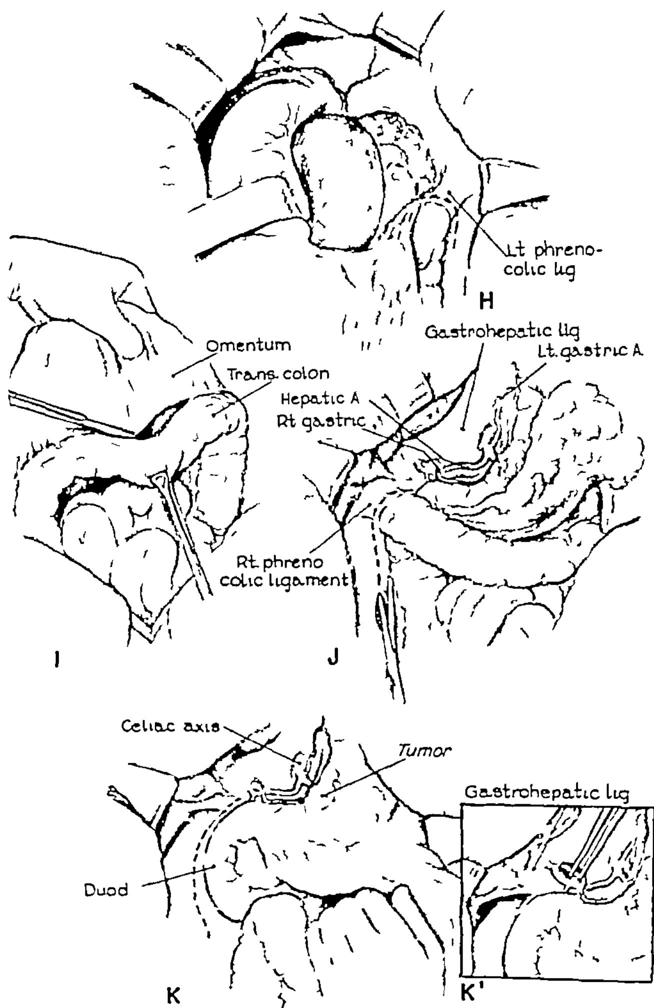
Discussion—Dr. Pack (cont.)

though the thoracic esophagus may be mobilized from below and drawn down into the abdomen for an added four to six cm. of length, there is some hazard of too much tension on the anastomosis. Furthermore, transection of the esophagus with abdominal anastomosis (below the diaphragm) may not be adequately high to ensure against recurrence in the proximal esophagus. In earlier years we were frequently disappointed to receive reports from the pathologist that the transection through the esophagus was above grossly visible cancer but microscopically detected cancer was found at the line of excision In consequence of this denouement, we consistently have requested frozen section microscopic analysis of the esophageal end of the surgical specimen before proceeding with the anastomosis In our experience, leaks in the anastomoses have occurred more commonly when the total gastrectomy is done solely from the abdominal approach

With an abdominothoracic incision, the diaphragm may be radially severed partway just for added exposure to enable mobilization of the thoracic esophagus and to construct an intrathoracic anastomosis, or it may be completely incised radially to permit an even wider exposure and mobilization of the entire esophagogastric segment.

If the left lobe of the liver be invaded by continuity with a gastric cancer on the lesser curvature side of the gastric cardia, one may perform a left hepatic lobectomy en masse with the stomach, spleen and distal pancreas.

In the performance of a total gastrectomy I dissect the inferior connections first, leaving the great omentum intact with the surgical specimen and freeing it completely from the transverse colon and the hepatic and splenic flexures which then can be packed downward and out of the way The mobilization from left to right is the same as shown in the illustrations, except for occasional differences. The body of the pancreas is transected and the stump closed at the end of this left to right maneuver with the specimen reflected toward the right side of the patient The transection of the duodenum and ligation of the right gastric and right gastroduodenal vessels are not done in patients whose cancers are of questionable operability until the surgeon is reasonably sure that the operation can be accomplished. The stomach will survive with intact esophagus and duodenum and with preservation of only the right gastric vessels. Elevation of the stomach specimen out of the abdomen and over the left costal arch (Moynihan maneuver) has the advantage of getting the specimen out of the way facilitating the exposure of and placing


Lt phreno-
colic lig
H
Gastrohepatic lig
Lt. gastric A
Omentum
Trans. colon
Hepatic A
Rt gastric
Rt. phreno
colic ligament
I
J
Celiac axis
Tumor
Gastrohepatic lig
Duod
K
K'

L, L[1] The duodenum and the head of the pancreas are mobilized and retracted upward and medialward to expose the related retroperitoneal structures. The distribution of the lymph nodes in relation to the aorta, the inferior vena cava, the left renal vein, and the common bile duct are shown. When an esophagoduodenostomy is planned following total gastrectomy for carcinoma of the stomach, the exposure and removal of the lymph nodes depicted is routinely done (L[1]) This does not usually obtain when an esophagojejunostomy is performed Accordingly when an esophagoduodenostomy is done, one performs not a less but, on the contrary a more radical operation

M. The pyloroduodenal area is retracted upward by a rubber tissue traction tape inserted through the lesser sac, and the gastroduodenal artery and its two branches, the superior pancreaticoduodenal artery and the severed right gastroepiploic artery are demonstrated. The inferior pancreaticoduodenal artery a branch of the superior mesenteric artery is visible.

N N[1] The stomach is displaced downward, and the exposed reflected layer of peritoneum overlying the esophagocardial junction is severed by scissor dissection to show the lower end of the esophagus and a portion of the hiatal ring. (N[1]).

O The lower end of the esophagus is first mobilized by digital dissection and encircled by a rubber tissue traction tape. With traction maintained, resection of the gastrohepatic omentum is performed, and the right (posterior) and left (anterior) vagus nerves are individually mobilized on a nerve hook and severed. Upon completion of this dissection the distal 5 to 8 cm. of the esophagus is freely mobile.

Discussion—Dr. Pack (cont)

the esophagus on a stretch, but a residual stomach tube should be thoroughly aspirated before this procedure, then withdrawn so the tip is in the lower esophagus, after which a large right angled clamp is placed across the esophagus below the level of transection in order to avoid possible flooding of the esophagus and trachea with a sudden upward gush of stomach contents.

In the restoration of continuity of the alimentary tract, although it is technically possible to anastomose the esophagus and duodenum in many cases (and I have done it within the thoracic cavity), the risk of leakage due to ischemic necrosis and/or tension on the suture line is greater than for esophagojejunostomy Theoretically and based on animal experimentation, the direct passage of food into the duodenum stimulates greater external pancreatic secretion than when the duodenum is bypassed by an esophagojejunostomy an advantage of this naturally would be less steatorrhea and creatorrhea after total gastrectomy Whenever the esophagoduodenal or esophagojejunal anastomosis is done below the diaphragm, an elevated peritoneal flap may be sutured over the anastomosis, a procedure which reinforces it and also serves as an additional suspension to relieve the weight and tension. The jejunojejunostomy (Braun supplementary anastomosis) may be enlarged to include the greater length of the jejunal limbs, thereby constructing a reservoir as a substitute stomach which may have some advantages in delaying the onset or lessening the degree of the occasional dumping syndrome which may follow total gastrectomy Substitutive stomachs have been constructed by the use of interposed segments of the jejunum or the transverse colon or the right colon with contained ileocecal valve between the esophagus and duodenum or esophagus and jejunum in an attempt to afford a temporary reservoir and to avoid some of the unpleasant sequels of total gastrectomy notably the dumping syndrome. In our hands the employment of these substitute stomachs has merely delayed and not lessened the frequency or severity of the post total gastrectomy syndrome The vasomotor phenomena characteristic of this symptom complex, such as a feeling of weakness, collapse pallor sweating, palpitation, and cardiovascular changes typical on the electrocardiogram and suggestive of coronary spasm may be delayed postprandially for 30 to 90 minutes longer than obtains with the conventional esophagoduodenostomy or esophagojejunostomy

P A Payr clamp is placed across the proximal portion of the duodenum, and two Babcock clamps are used to immobilize the duodenum distally The duodenum is transected distal to the Payr clamp and approximately 4 cm. below the pyloroduodenal junction A wide cuff of the duodenum is resected to encompass the zone of potential submucosal spread of the tumor To avoid crushing trauma and the unnecessary sacrifice of tissue, the distal segment of the duodenum is not cross-clamped.

Q To prevent soiling of the operative field, the open end of the duodenum is temporarily occluded by the approximation of its cut margins with Babcock clamps and then covered with a moist gauze pad The index finger is inserted into a plane of cleavage between the pancreas anteriorly and the portal vein posteriorly prior to transection of the pancreas at the site indicated by the dotted line.

R. Inset showing the pancreas being transected and a Babcock clamp in readiness to compress the cut margins of the pancreas. The *eccentric location of the orifice of the pancreatic duct* is also visible.

S. The division of the pancreas is completed, and for temporary hemostasis the cut margins are approximated by a series of Babcock clamps. The portal vein, formed by the junction of the superior mesenteric and splenic veins, may be seen passing obliquely upward beneath the arch formed by the hepatic artery and its gastroduodenal branch. This vascular arch is a useful landmark for the location of the underlying portal vein The line of division of the peritoneal attachment of the inferior border of the pancreas is shown in dotted outline

T The operative field, essentially as in S, with the cut margins of the pancreas now approximated with mattress sutures of silk (00) and the mobilization of the inferior border of the pancreas completed

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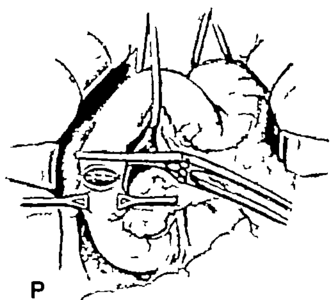
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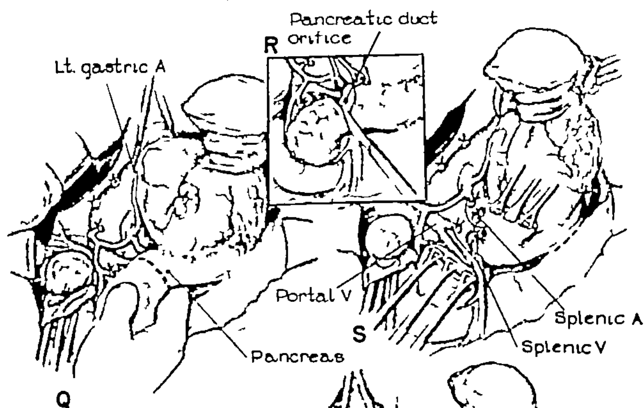
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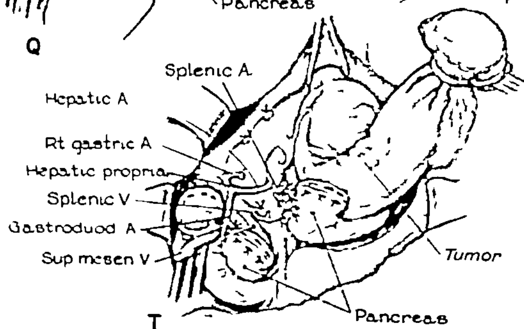
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Plate 111


P


Pancreatic duct orifice
R
Lt. gastric A
Portal V
S
Splenic A
Splenic V
Pancreas
Q


Splenic A
Hepatic A
Rt gastric A
Hepatic propria
Splenic V
Gastroduod A
Sup mesen V
Tumor
T
Pancreas

U The surgical specimen is elevated upward and to the left to place on tension the remaining vascular attachments of the stomach, *the left gastric vessels. These vessels* are triply clamped close to the celiac axis to include the lymphatic drain, and the line of severance between the two distal clamps is indicated.

V The surgical specimen is further elevated, and two guy sutures of silk are inserted through either side of the lower portion of the esophagus The whole of the related retroperitoneal structures is now visible.

W The bulky specimen is removed as it is a hindrance rather than a traction aid in the performance of the anastomosis. The duodenum and esophagus are now ready for their approximation by sutures.

X *1* The first layer posteriorly of interrupted sutures of silk (000)
2 Alternate and frequently preferred *method of using interrupted through and* through mattress sutures of silk (000) for the first layer posteriorly
3 The second layer posteriorly of interrupted through and through sutures of silk (000)

Y *1* The first layer anteriorly using interrupted sutures of silk (000) The two angle sutures are inserted from "inside out" to "outside in" to place the knots on the inside of the lumen.
2 The first layer anteriorly is completed.
3 The completion of the second layer anteriorly with interrupted mattress sutures of silk (000)
4 5, 6, 7 Alternate method for the insertion of sutures anteriorly
4 5. The first layer of sutures which are inserted from the "inside out to outside in" to place the knots on the inside of the lumen.
6. The completion of the first anterior layer of sutures, the centermost one being a figure of 8 mattress suture with the knot on the outside
7 The completion of the second layer of sutures using interrupted mattress sutures of silk (000).

Z. The anastomosis between the esophagus and duodenum is completed. The common bile duct, though abnormally displaced, is *unobstructed. A drain is inserted into the left subphrenic space* and a layer closure of the wound completes the operation The use of a flap of peritoneum to suspend the site of anastomosis and take tension off the suture line is frequently recommended In my own experience in the majority of patients this has not proved technically feasible and, accordingly its applicability has been limited

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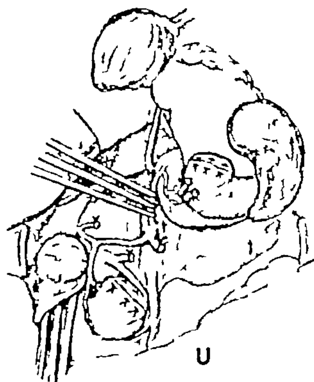
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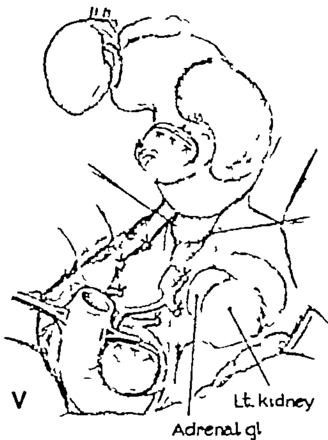
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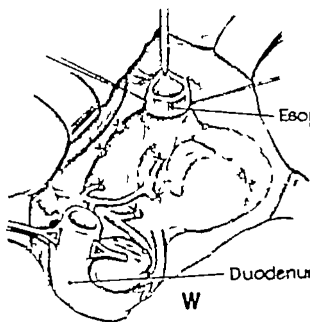
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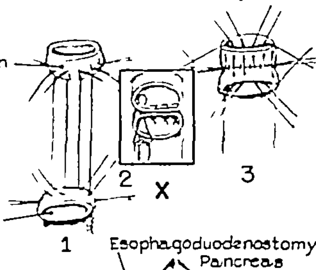
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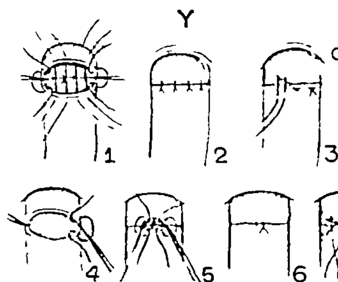
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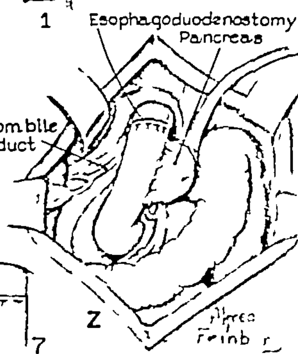

U


V
Lt. kidney
Adrenal gl


Esoph
Duodenum
W


1
2
X
3


Y
1
2
3
4
5
6
7


Esophagoduodenostomy
Pancreas
Com. bile duct
Z

Z Z Z Z Alternate methods of anastomosis, using jejunum rather than duodenum

Z Antecolic end to-side esophagojejunostomy

Z'' Retrocolic end-to-side esophagojejunostomy and jejunojejunostomy

Z'' Z''' End to-end antecolic (Z'') or retrocolic (Z''') esophagojejunostomy and end to-side jejunojejunostomy

The interposition of ileocolic, colic, or jejunal segments for restoration of alimentary continuity is not practiced. The only apparent advantage of such procedures is that they restore direct continuity between the stomach and duodenum which is more readily and easily accomplished by a direct end-to-end esophagoduodenostomy as illustrated. The value of interposed segments in the establishment of artificial gastric reservoirs and the prevention of symptoms relative to the dumping syndrome is seriously questioned.

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Antecolic esophagojejunostomy

Retrocolic esophagojejunosto

Duod

Duod

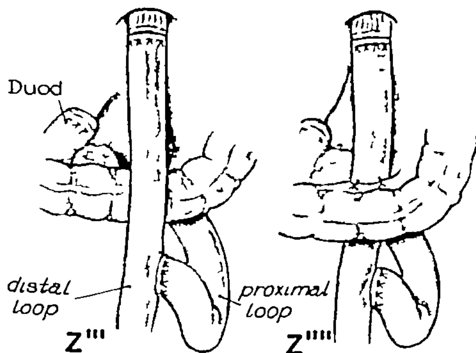
Z'

Z''

Entero-enterostomy

Jejunum

distal loop – proximal loop



PYLOROMYOTOMY (FREDET–WEBER–RAMSTEDT OPERATION)

A. The right upper quadrant paramedian muscle-splitting incision utilized is depicted in dotted outline If preferred, a transverse *incision may be used. The shadowed area* between the lower end of the incision and the umbilicus is indicative of a peristaltic wave, proceding obliquely downward from left to right and visible at the time of operation.

B. The incised margins of the posterior rectus sheath and the anterior parietal peritoneum are grasped in clamps, and the opening into the peritoneal cavity is extended upward by scissor dissection and downward with a scalpel.

C. The wound margins are retracted, and, first, the transverse colon and the transparent omentum overlying are withdrawn from the peritoneal cavity Next, by manual traction the stomach is displaced upward into the wound and the pyloric tumor the pathog nomonic characteristic of infantile pyloric stenosis, is readily visible.

D The pyloric tumor is immobilized securely between the thumb and the index finger of the left hand of the surgeon, and in the relatively avascular plane midway anteriorly a longitudinal incision is made. To minimize the possibility of entrance into the lumen of the duodenum the direction of the incision is always from the duodenum toward the stomach. It is not the opening into the duodenum but the failure of its recognition that is dangerous It may be recognized by the sudden appearance of bile-stained foam. Satisfactory closure is obtained with usually one, or at the most two interrupted silk (0000) sutures

E, F The relatively superficial seromuscular incision overlying the pyloric tumor is deepened gradually by blunt dissection with *a fine curved clamp and the underlying* layer of circular muscular fibers is exposed. During this dissection toward the pyloroduodenal junction, caution again must be observed to prevent accidental perforation into the lumen of the duodenum.

G The layer of circular muscle fibers, mobilized on a clamp, is being severed by scissor dissection. In this dissection it is most important to sever all of the constricting fibers to permit a satisfactory herniation of the underlying mucosa.

H. Following the severance of all constricting fibers, blunt tissue dissection with a clamp is continued in the plane between the mucosa and the hypertrophied muscle layers first on one and then on the other *side of the pyloromyotomy incision This* is done to assure the severance of all con stricting muscle fibers.

I. The Ramstedt pyloromyotomy is completed, and the mucosa is seen herniated through the incision.

J A cross-section diagram of the completed operation depicting the herniation of the mucosa between the severed fibers of the hypertrophied muscle layers.

K. The incision is closed in layers using inter rupted horizontal everting mattress sutures of silk (0000) for the peritoneum and inter rupted sutures of silk (000) for both the fascia and skin.

Discussion—Dr. Edward J Donovan. In doing a Fredet Ramstedt operation for congenital pyloric stenosis, I prefer to use a much shorter incision and place it higher than the one depicted here for the following reasons

1 I wish to have the incision one cm. lateral to the xiphoid process and seven cm long so that the right lobe of the liver completely covers it on the in side and has to be retracted upward to expose the pylorus. The liver then makes a splendid buffer for the incision and aids greatly in preventing disruption of the incision, which occurs quite frequently in these poorly nourished infants.

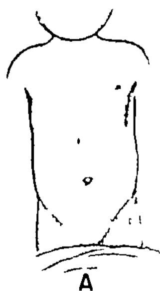
2 *One need only deliver the pylorus into the incision in performing this operation. The transverse colon and the omentum need not be seen, thereby* eliminating the trauma of replacing these structures in the peritoneal cavity

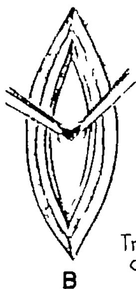
The pyloric vein shows very well in D This is a very important landmark showing the junction of pylorus and duodenum and is very constant in its location. If the incision in the pylorus goes beyond the pyloric vein one is very apt to open the duodenum, since the pyloric tumor projects into the duodenum as the cervix does into the vagina. Plate 114, G shows the circular muscle of the pylorus being cut with scissors as a separate layer I believe that this is unnecessary and possibly dangerous and could result in injury to the mucous membrane. If the incision in the pylorus is made just a little deeper with the scalpel, the cut edges of the circular muscle will spread easily with the clamp as shown in F Use of the clamp as depicted in H is not believed necessary

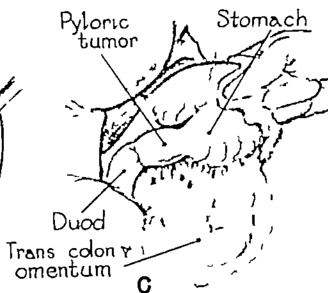
The Fredet Ramstedt operation is a very simple one, but it must be done carefully Opening into the *duodenum is preventable if the proper precautionary measures are observed during the operation. Perforation of the duodenum may result in the child's* death from peritonitis. Pyloromyotomy is one of the most satisfactory operations in infant surgery and, when properly performed, effects a complete and permanent cure. This is proved by the multiple long range follow-up studies reported in the medical literature

REFERENCES (see page 637)

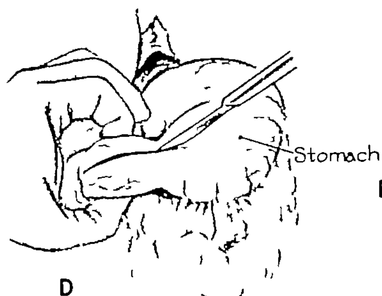
Plate 114


A

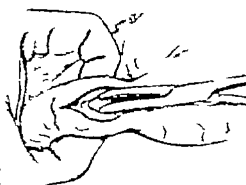

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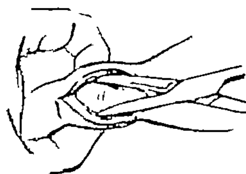


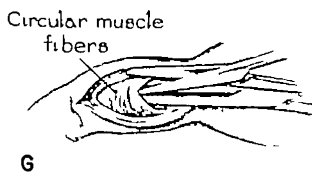
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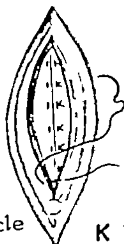
D


E

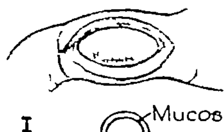

F

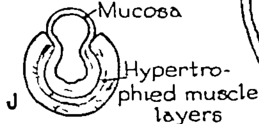


G


K

H


I



J

REPAIR OF PERFORATED DUODENAL ULCER

The technic of closure illustrated is a modification of the method described by the late Roscoe Graham of Canada. In Graham's technic the tab of omentum is used as a plug and is anchored into the site of perforation by the sutures which were previously inserted but not tied.

In the surgical management of perforated duodenal ulcers, it is the general practice of the author to employ simple suture closure of the perforation. Admittedly 60 to 70 per cent of the patients so treated will have recurrent ulcer symptoms at varying intervals following the operation. However subsequent treatment, either medical or surgical, may be prescribed on a purely elective basis according to the individual needs of the patient.

Partial gastrectomy as a primary definitive procedure was stressed in particular by Von Haberer in 1919 Although popular amongst surgeons on the Continent for many years, it has assumed popularity in the United States only in relatively recent years. Admittedly in some instances partial gastrectomy may be performed, either as a procedure of choice or as a mandatory operation according to the operative findings in the particular patient. However its use as a routine procedure is not considered advisable.

In some patients with acutely perforated duodenal ulcers, conservative management by nasogastric suction, parenteral alimentation, and antibiotic therapy may be prescribed. This method, reported upon by the author in 1943 is used as a selective rather than routine method of treatment. Prior to 1943 Wangensteen and others were advocates of its use. More recently Taylor of England and Seeley of the United States have been its staunchest proponents.

In summary the choice of treatment for an acute perforated duodenal ulcer is dependent upon the particular findings, both clinical and operative, in the individual patient, and upon the judgment of the surgeon based upon his technical skill and experience. In general simple closure of the perforation is preferred.

A. The right upper quadrant paramedian muscle-retracting (lateral) incision employed is indicated by the dotted line

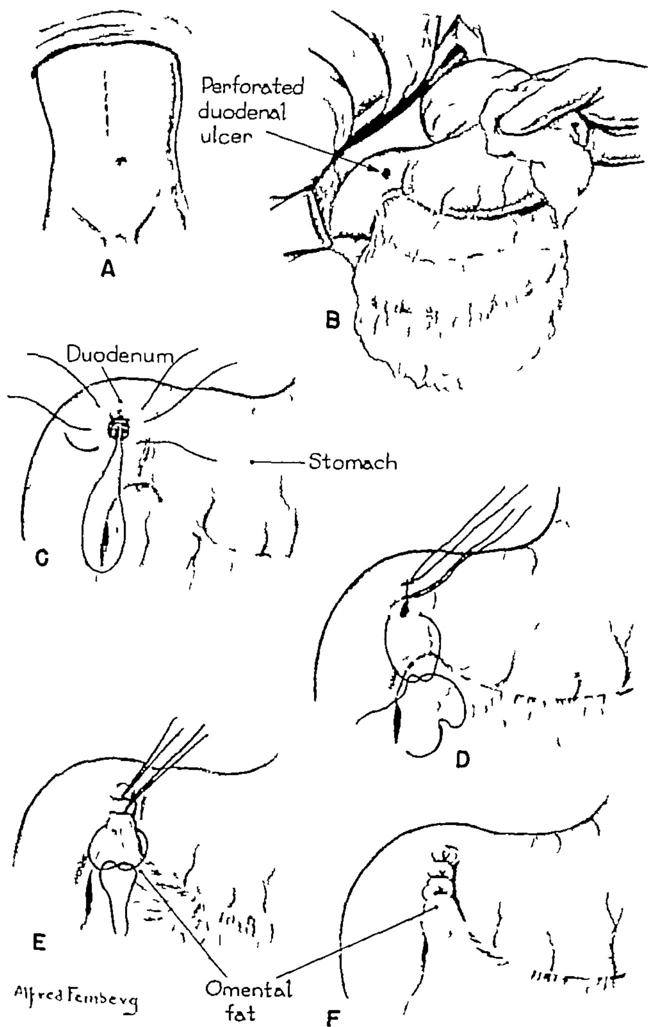
B. The peritoneal cavity is entered and by manual retraction on the stomach, the site of perforation in the first portion of the duodenum is exposed.

C. Close-up view showing the insertion of the interrupted silk (00) sutures swedged on minimum trauma needles for the closure of the perforation. In the large perforations, the needle is first inserted well back on the gastric side and has its exit through the site of perforation. The needle is then reinserted through the perforation and has its exit on the duodenal side as depicted. In the small perforations, adequate closure is obtained with a single rather than double insertion of each suture needle.

D E, F The sutures are all first inserted and tied individually (D) In tying the sutures, tension on the suture line is avoided because the sutures easily pull through the friable and edematous tissue surrounding the perforation. Following the completion of the closure of the perforation, the long strands of the sutures are separated and subsequently tied about a piece of omental fat which is drawn up to reinforce the line of closure (E, F).

DISCUSSION—DR. AUBRE DE L. MAYNARD I must commend the author for a lucid presentation of his subject, the excellent illustrations, and the concise but substantial text. My initial comment shall relate to the steps of the author's procedure as they are outlined.

The right upper quadrant muscle retracting incision (A), though commonly used, is rarely my choice For the very ill patient, it is tedious and time consuming. I prefer rapid entry into the abdomen by way of a midline incision with its minimum of bleeding. I must emphasize that to get the full benefit of this incision, it must be accurately midline. Extending from xiphoid to umbilicus, it gives excellent exposure and permits the carrying out of gastric resection with facility should this be necessary


A
Perforated
duodenal
ulcer
B
Duodenum
Stomach
C
D
E
Omental
fat
F
Alfred Feinberg

REPAIR OF PERFORATED DUODENAL ULCER

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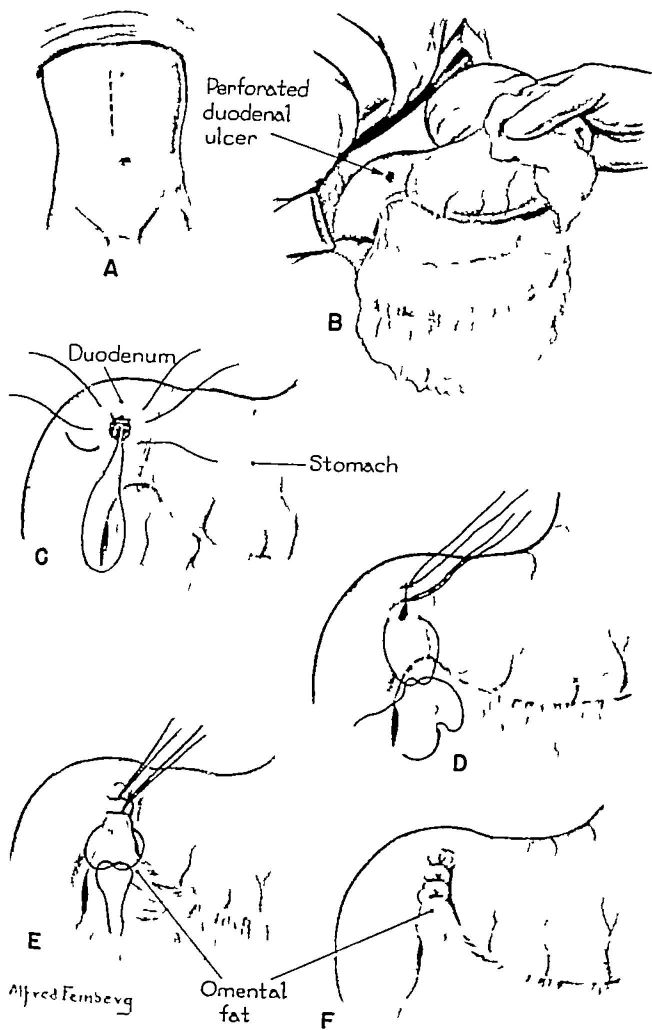
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D E, F The sutures are all first inserted and tied individually (D) In tying the sutures, *tension on the suture line is avoided* because the sutures easily pull through the friable and edematous tissue surrounding the perforation. Following the completion of the closure of the perforation, the long strands of the sutures are separated and subsequently tied about a piece of omental fat which is drawn up to reinforce the line of closure (E, F).

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Perforated duodenal ulcer
Duodenum
Stomach
Omental fat
A
B
C
D
E
F
Alfred Feinberg

DISCUSSION—DR. DE L. MAYNARD (cont.)

Manual retraction of the stomach, forward, to the left, and slightly downward (B), is the key maneuver in the exposure of the perforation. It brings into the operative field, with a minimum of trauma, the area that is the usual seat of involvement, namely the anterosuperior surface of the duodenum, pylorus, and juxtaposed stomach. Infrequently a tiny perforation, temporarily obturated or undergoing spontaneous closure, may be obscure and difficult to detect. But in most cases the perforation is quite obvious or easily detected. Preliminary to suture closure, the perforation, with its surrounding inflammatory zone, should be freed from any contiguous protective attachments.

The author sets forth his modification of the classic technic of Roscoe Graham. The placement and number of sutures is in the Graham manner (C), except that silk (00) is used instead of catgut. Unlike the Graham technic, in which the omentum is used as a plug without approximation of the margins of the perforation, the author favors closure through approximation of those margins (D), applying the attached omentum over the site as shown (E, F). By his own admission, the sutures traverse the zone of edema and inflammatory infiltration surrounding the perforation and, in effecting a closure without tension, cut through the friable edematous tissue.

That this is sound or desirable surgical practice is at least debatable. That it has been effective surgical practice is inherent in the author's successful use of the technic. Of the many varieties of surgical closure, I have never used Dr Madden's method, but have confined myself in difficult closures to Graham's technic, using catgut sutures. It has been consistently effective. Whenever I have employed a free omental graft, I have subsequently mantled the entire area with attached, viable gastrocolic omentum, fixed at focal points with fine silk sutures (0000). This provides added protection and further stimulates fibrin deposition and fibrogenesis over the site.

I would like to stress that, concomitant with surgical closure, continuous nasogastric suction is an indispensable ancillary measure. It should be instituted as soon as the diagnosis is made and maintained through and beyond operation, for as long as indicated. In my opinion, this measure is an important contribution to the success of any method of closure and to the eventual outcome.

In making further comment, it might be of interest to state our present attitude about the problem of the perforated ulcer

In so far as immediate prognosis is concerned, one cannot dispute the fact that suture closure is a satisfactory method of treatment. It stops the peritoneal contamination and ordinarily controls the threat to life, but it does not, per se, influence the underlying ulcer pathology In most instances, with the addition of nasogastric suction to immobilize the inflamed area and defunctionalize the stomach, healing does take place and recovery ensues. But the method is plagued with a high incidence of late poor results, 40 per cent to 70 per cent of the patients have the unhappy sequelae of reactivation of ulcer activity re perforation, pyloric stenosis, and hemorrhage.

In November 1953, trying to come to grips with this disturbing reality we introduced emergency gastric resection for use in selected cases. There was initial difficulty in establishing positive criteria for its use, but we eventually settled on the following.

Gastric resection could justifiably be applied in cases of

1 Perforation in a gastric ulcer that from size, situation, and character was suspect of malignancy
2. Peptic ulcers that had a long history (certainly more than a year), and a pathology of unmistakable chronicity—
   (a) the presence of pyloric stenosis
   (b) multiple ulcers
   (c) perforation associated with bleeding
   (d) reperforation
   (e) a non-recent adhesive pathology about the involved pyloroduodenal segment.
3 The occasional perforation with callus and indurated margins and with such an intense and extensive inflammatory reaction around it that closure, even by the Graham technic appeared hazardous. It is quite possible also that this type of severe reaction may offer as much danger as the perforation, therefore the lesion would be better out by resection than left in by closure.

Within that general framework, primary gastric resection, identical with the procedure in elective cases, was applied by a number of senior residents under the supervision of a team of competent gastric surgeons with commendable results. In a group of 84 patients to date, 42 were treated by emergency gastric resection with 1 death, 40 were treated by suture closure with 4 deaths, and 2 were treated by nasogastric suction with 2 deaths. The mortality in the resection group came from delirium tremens and not peritonitis. The 4 mortalities in the closure group were attributed to peritonitis and sepsis in 2 cases and delirium tremens in 2 cases. Nasogastric suction was reserved for two types

1 The "formes frustes" type described by Singer and associates, in which the catastrophe is short-lived, the course exceedingly mild and non-progressive, suggesting that control has taken place either by spontaneous closure or through a sealing off of the perforation by contiguous structures.
2. Patients so perilously ill from toxemia and/or bacterial peritonitis as to preclude surgical intervention of any sort.

Our results with primary gastric resection have so far been heartening and have convinced us that there is a place for this major procedure in treating this emergency We are hopeful that over a longer period of time, with a much larger volume of cases, it will be possible to arrive at unassailable criteria for its use in selected cases.

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STENOSIS ATRESIA, AND DIAPHRAGMATIC OCCLUSION OF THE DUODENUM

This plate depicts diagrammatically the analogy between the congenital defects of the duodenum and those in the region of the aortic arch. In each, the congenital defect occurs at the site of an embryologic event. More over the comparative anatomic similarity is striking despite the fact that in the development of the aortic arch there is no solid phase. This similarity is particularly well illustrated between diaphragmatic occlusion of the duodenum and coarctation of the aorta of the "adult" type (C and C[1]).

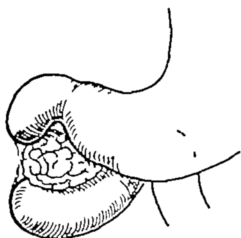
The exact mechanism for the occurrence of congenital anomalies of the duodenum and, in particular of diaphragmatic occlusion is unknown Although many hypotheses have been proposed, the two that are believed to merit discussion most are those of Bland Sutton and Tandler

In 1889 John Bland-Sutton reported a case of small bowel obstruction caused by a complete diaphragmatic occlusion of the ileum. The diaphragm was located in the ileum at the site corresponding to the entrance of the vitelline duct in the embryo Accordingly it was stated that congenital obstruction and narrowing of the alimentary canal was always found at the site of embryologic events. To substantiate this hypothesis Bland Sutton cited the following anomalies of the gastrointestinal tract (1) an imperforate pharynx occurs at the site where the foregut and the stomadeum come into contact, (2) an imperforate or septate duodenum occurs in the region of the papilla of Vater where the diverticula issue to form the liver and the pancreas, (3) imperforate rectum and anus are due to imperfect union of the hindgut and the proctodeum, and (4) an imperforate ileum occurs in the region where the primitive alimentary canal is in communication with the yolk sac by means of the vitelline duct.

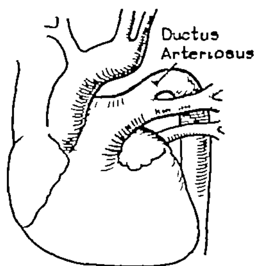
In 1900 Tandler working with embryos of 30 to 60 days obtained by operations for ectopic pregnancies, stated that during this period of development the lumen of the duodenum is "more or less completely" obliterated and in the so-called "solid" stage. It was further stated that subsequent to the tenth week, vacuoles appear which coalesce and ultimately reestablish the continuity of the lumen. From this study it was postulated that arrests in development occurring during this transitional phase (second to third months) were a logical explanation for the occurrence of atresias stenoses, and diaphragmatic occlusions of the duodenum. This study was confirmed by both Kreuter and by Forssner Furthermore, Kreuter was of the opinion that the stage of epithelial occlusion was not limited to the vaterian segment of the duodenum, as Tandler concluded, but that it extended throughout the whole of the small intestine

The hypothesis of Bland Sutton is believed to be the most logical and acceptable of any that have been promulgated. It is particularly adaptable to congenital anomalies of the duodenum. Furthermore, it offers a satisfactory explanation for the occurrence of congenital anomalies other than in the gastrointestinal tract. In the duodenum, atresias, stenoses, and diaphragms occur almost invariably in the vaterian segment. This segment is the site of origin of the anlage of the liver biliary tract, and pancreas, and also the site of junction of the foregut and the midgut. The main objection to this hypothesis, voiced by many is that similar anomalies occur either alone or concomitantly in other parts of the intestines which are not the site of embryologic events

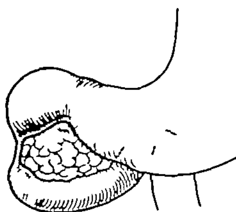
The hypothesis of Tandler is believed less tenable than that of Bland-Sutton. This, however is a minority opinion Schridde (1909) in an examination of 50 human embryos in stages of development corresponding to that described by Tandler Kreuter and Forssner was unable to demonstrate epithelial occlusions in any portion of the intestinal tract. More recently Schwegler and Boyden have questioned the presence of a "solid" phase during the development of the duodenum. Although admittedly less frequent, atresias, stenoses, and



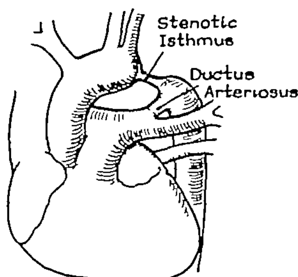
ATRESIA OF DUODENUM
A



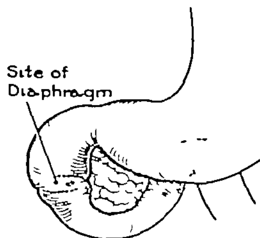
ATRESIA OF AORTA
A'



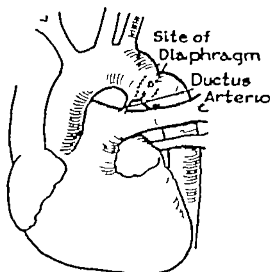
STENOSIS OF DUODENUM
B



COARCTATION OF AORTA
Infantile Type
B'



DIAPHRAGM OF DUODENUM
C



COARCTATION OF AORTA
Adult Type
C'

diaphragms occur in the colon despite the fact that a "solid" phase does not occur in the development of the large bowel. Furthermore, similar anomalies occur in areas other than the gastrointestinal tract, in which there are no preexisting "solid" phases in development but which are the sites of embryologic events. This is most notably exemplified in the arch of the aorta. Despite the absence of a "solid" phase the congenital anomalies of the aortic arch are believed analogous to those that occur in the duodenum and are depicted in Plate 116 This analogy tends to negate the hypothesis of Tandler and to lend credence to the one of Bland Sutton.

Atresia and stenosis (coarctation of the "infantile" or "adult" type) of the aorta occur at the site of an embryologic event, namely the region of the juncture of the third and fourth aortic arches This region is also the site of communication between the pulmonary artery and the aorta through the ductus arteriosus (Botalli). Coarctation of the "adult" type simulates closely congenital diaphragmatic occlusion of the duodenum (Plate 116 C, C). In each, a diaphragm placed obliquely across the lumen is present The diaphragm may or may not be perforated, but if a perforation is present, it is usually eccentric. Finally the site of the diaphragm is indicated externally by a constriction or slight indentation of the wall.

In summary one may state that the exact mechanism for the developmental anomalies of the gastrointestinal tract is unknown. However from the knowledge that is available, it is believed that the concept expressed by Bland Sutton is the most logical and the one that is the most universally applicable

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The type of operation and the order of preference in the treatment of duodenal atresia (A) and duodenal stenosis (B) are depicted.

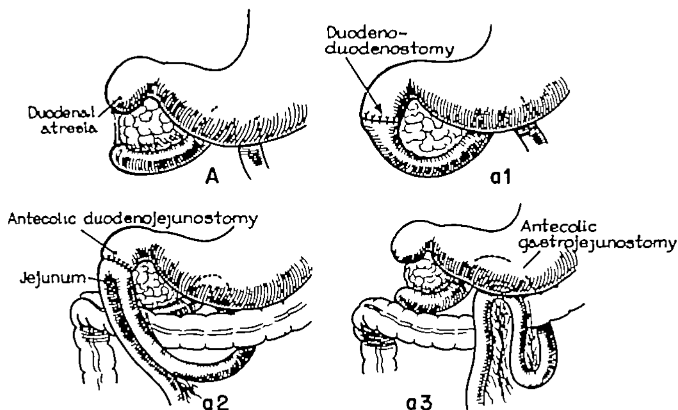
A. This is a diagrammatic representation of an atresia of the duodenum seen at operation. It is characterized by a discontinuity of tissue in the second portion of the duodenum distal to the site of entrance of the papilla of Vater

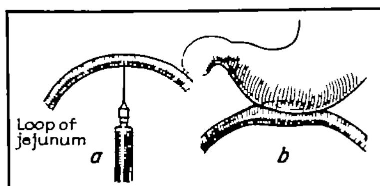
a 1 The ideal operation for atresia, one which relieves the obstruction and restores the continuity of the duodenum, is an end-to-end duodenoduodenostomy as depicted.

a 2. In the event that the restoration of direct continuity of the duodenum is not feasible, either an antecolic duodenojejunostomy as illustrated (*a 2*) or a retrocolic duodenojejunostomy may be performed In fact a duodenojejunostomy is the operation most commonly performed in the surgical management of duodenal atresia.

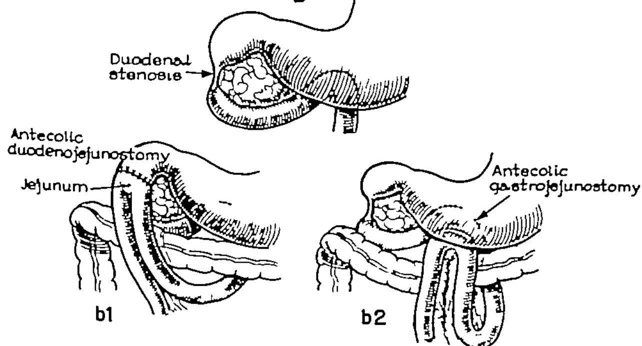
a 3 In some instances the performance of the least acceptable, but at times life saving operation, namely gastrojejunostomy may be required. The disadvantage of a gastrojejunostomy is the fact that adequate decompression of the "blind" duodenal segment is not obtained. Accordingly when it is filled, retrograde regurgitation into the stomach occurs with repeated cyclic attacks of vomiting. In the inset (*a, b*) the technic for enlarging the lumen of the collapsed jejunum, by the injection of sterile saline solution preparatory to anastomosis, is shown

B. In like manner duodenojejunostomy (*b 1*) or gastrojejunostomy (*b 2*) may be performed in the treatment of duodenal stenosis Of the two operations duodenojejunostomy retrocolic or antecolic (*b 1*), is preferred. The objection to gastrojejunostomy (*b 2*) is the same as previously stated namely recurrent attacks of vomiting, secondary to regurgitation of the obstructed duodenal contents into the stomach


Duodenal atresia
A
Duodeno-duodenostomy
a1
Antecolic duodenojejunostomy
Jejunum
a2
Antecolic gastrojejunostomy
a3


Loop of jejunum
a
b

B


Duodenal stenosis
Antecolic duodenojejunostomy
Jejunum
b1
Antecolic gastrojejunostomy
b2

This plate depicts the direct (A – Morton, B – Peterson) and indirect (C) approaches in the surgical management of diaphragmatic occlusion of the duodenum.

A. The diaphragmatic occlusion of the duodenum is depicted. The indentation of the outside wall of the duodenum at the level of the papilla of Vater corresponds to the site of the diaphragm. The eccentric orifice in the diaphragm is visible.

a1 a2 a3 a4 *This series of illustrations demonstrates* the technic described by Morton for the treatment of diaphragmatic occlusion of the duodenum. The method is simple, direct, and effective. The hepatic flexure of the colon is mobilized, and the whole of the duodenal loop is exposed. A longitudinal incision is made in the anterior wall of the duodenum at the site of the diaphragm, above and below which it extends into the lumen of the duodenum (*a 1*). The diaphragm *is secured in tissue forceps and* transected ("bivalved") by scissor dissection (*a 2*). Each half of the transected diaphragm is excised, and the closure of the duodenum in a plane transverse to its longitudinal axis is begun (*a 3*). A two layer closure with interrupted silk (0000) sutures completes the operation (*a 4*). The enlargement of the diameter of the lumen of the duodenum by the transverse closure is demonstrable (*a 4*). In using this method one should refrain from inserting ligatures in the cut margins of the diaphragm because of danger of occlusion of either or both the common and pancreatic ducts. These structures course between the mucosal layers of the diaphragm and may be occluded by a suture, particularly one of the continuous type.

B *b1 b2 b3* The technic for the surgical treatment of diaphragmatic occlusion of the duodenum recommended by Peterson is illustrated. Similarly as in the technic described by Morton, a longitudinal incision is made into the lumen of the duodenum and the diaphragm is simply transected (*b 1*). This provides an adequate lumen and does not require the resection of any portion of the diaphragm. In preparation for closure of the duodenotomy incision at right angles to its long axis, the midportions of the cut margin of the longitudinal incision are grasped in clamps (Babcock) or preferably traction guy sutures of 00 silk. Traction is maintained in a plane at right angles to the long axis of the bowel (*b 1*) and a suture to approximate the proximal and distal points of the linear incision is inserted (*b 1*) and tied (*b 2*). Similarly as in the technic described by Morton (*a 1–a 4*) a two layer transverse closure of the duodenum with interrupted sutures of silk (000) is performed (*b 3*).

C, *c1 c2* In addition to the direct approaches of Morton (A) and Peterson (B) in the treatment of diaphragmatic occlusion of the duodenum, an indirect operative procedure may be employed (*c 1 c2*). This may consist of either a side-to-side duodenojejunostomy (*c 1*) or a side to-side gastrojejunostomy (*c 2*). The first of these operations, namely duodenojejunostomy is an acceptable substitute to either transduodenal excision (Morton) or transection (Peterson) of the diaphragm. However gastrojejunostomy as an elective operation, should not be performed because the duodenum proximal to the diaphragm may become enormously dilated. Consequently regurgitation of large quantities of ingested foodstuffs into the stomach occurs and incites chronic recurrent attacks of vomiting. A gastrojejunostomy should only be employed if considered mandatory in saving the life of the patient. In the recorded instances in which this operation was used as a primary method of treatment, secondary corrective procedures either duodenoduodenostomy duodenojejunostomy or duodenotomy with incision or excision of the diaphragm, have been required.

A—MORTON

Perforated duodenal diaphragm

Long Incision

a1

Excision of diaphragm

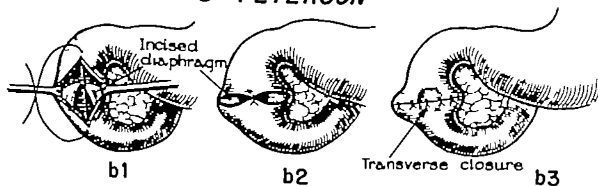
a2

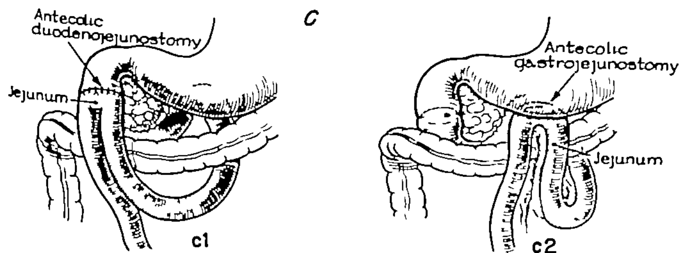
a3

Transverse closure

a4

B—PETERSON

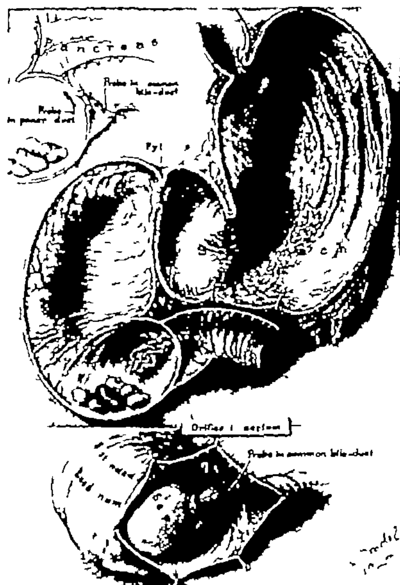




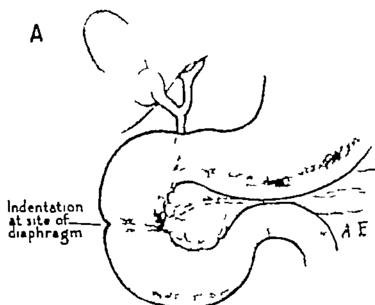
A. Artist's illustrations of findings at operation in a patient with an intrinsic obstruction of the duodenum secondary to a diaphragm. The symmetrical dilatation both above and below the level of the diaphragm and the indentation of the wall of the duodenum corresponding to the site of attachment of the obliquely placed diaphragm are visible. The uniformity in the caliber of the duodenum proximal and distal to the diaphragm is a characteristic finding and frequently the reason for failure of making the diagnosis at operation. All too frequently the presence of an innocuous peritoneal membrane is incorrectly considered the cause of the obstructive symptoms that are manifest.

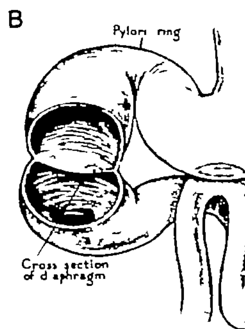
B. Artist's illustration of findings in a second patient in whom a diaphragmatic occlusion of the duodenum was present. In infancy a retrocolic gastrojejunostomy was performed. The postoperative course was complicated by the occurrence of intermittent attacks of vomiting of progressive severity. Finally at the age of ten years, exploratory laparotomy was performed. The symmetrical dilatation of the duodenum above and below the diaphragm, the eccentric perforation, the constriction or indentation of the wall of the duodenum at the site of attachment of the diaphragm, and the retrocolic gastrojejunostomy performed previously are shown. The illustration in the inset depicts the oblique position (45 degree angle) of the diaphragm.

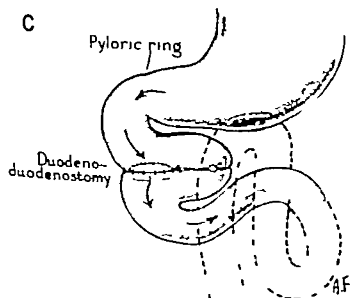
C. This is a drawing to show the operation performed in this patient, namely a side-to-side duodenoduodenostomy to bypass the obstruction caused by the diaphragm. Because of the redundancy and dilatation of the duodenum that was present, the type of bypass anastomosis depicted was easily accomplished.



D. "Upper sketch: esophagus, stomach, and duodenum opened after fixation in formalin.
"Lower sketch: duodenal lumen with septum shown from the jejunal side.
"Drawing in upper left corner: diagrammatic representation of the course of the biliary and pancreatic ducts in relation to the duodenal septum, its surfaces and orifice." (Courtesy of S. M. Seidlin, M. D., and Bull. Johns Hopkins Hosp.)


A
Indentation at site of diaphragm
A F


B
Pylori ring
Cross section of diaphragm


C
Pyloric ring
Duodeno-duodenostomy
A.F

In patients with intrinsic obstructions of the duodenum, the primary symptom is persistent vomiting. Characteristically the vomitus contains bile, but bile may be absent, as its presence depends upon the site of entrance of the common bile duct relative to the obstruction. The vomitus is frequently "coffee ground" and oftentimes frankly bloody.

A deep icterus is commonly present. In fact, the combination of icterus and bloody vomitus occurs so frequently that it has been considered diagnostic of congenital obstructive anomalies of the duodenum. Reportedly in such cases the incidence of icterus is 40 to 45 per cent and that of bloody vomitus is 60 to 85 per cent. Furthermore, it is frequently stated that there is an increase in other congenital malformations in association with intrinsic obstructions of the duodenum, particularly mongolism. This was first mentioned by Fanconi and subsequently observed by others.

Epigastric distention and visible gastric peristalsis are prominent objective symptoms. The dilated first portion of the duodenum may be easily felt and it is frequently misinterpreted as a "palpable tumor."

If the correct diagnosis is not made and the proper treatment is not given, in the majority of patients the symptoms are progressive and are associated with rapid and pronounced weight loss, severe fluid and electrolyte imbalance and ultimately the death of the patient.

In every newborn with persistent vomiting, the diagnosis of duodenal obstruction must be considered and either confirmed or negated as quickly as possible. This is most important when one considers the fact that the condition of infants with obstructive anomalies of the duodenum deteriorates rapidly. Accordingly if the diagnosis is unduly delayed, the patient becomes an extremely poor surgical risk.

In addition to the symptoms previously mentioned, a careful study of the plain or "scout" roentgenograms of the abdomen taken in both the upright and inverted positions is a valuable aid in diagnosis. Characteristically these films demonstrate a gas-filled stomach and first portion of the duodenum with little or no gas shadows in the remainder of the intestines. Unfortunately and too frequently such findings have been considered diagnostic only in retrospect. In the event that the diagnosis still remains in doubt, the instillation of small amounts (30 to 60 ml.) of warm iodized oil (lipiodol) or a light barium mixture through a nasogastric tube (No. 8F) is almost invariably confirmatory. Although both oil and barium have been used, the oil is preferred in the newborn because of the ever present danger of the aspiration of regurgitant gastric contents and resultant pulmonary complications.

The two main conditions which should be differentiated from congenital obstructive anomalies of the duodenum are esophageal atresia and infantile pyloric stenosis.

Esophageal atresia. In atresia of the esophagus vomiting occurs during rather than after each feeding and is associated with varying degrees of cyanosis. The vomitus consists of the unchanged feeding and does not contain bile. Salivation between each feeding is excessive. "Scout" roentgenograms of the abdomen will show either abundant gas shadows throughout the whole of the gastrointestinal tract or none at all, as the shadows depend upon the presence or absence of an associated tracheoesophageal fistula. A nasogastric tube (No. 8F) may be inserted only a short distance before an obstruction is met. Finally the instillation of two to three ml. of warm iodized oil (lipiodol) followed by a roentgenogram of the chest, including the cervical region, will depict clearly the cul-de-sac of the proximal segment of the esophagus.

In *infantile pyloric stenosis* the vomiting is usually delayed until the third or fourth week and the vomitus does not contain bile. The fact that the vomiting is projectile is not of differential diagnostic aid since the same may occur with obstructive anomalies in the duodenum. Furthermore, the absence of bile is not an absolute differential aid because the same may obtain in intrinsic obstructions of the duodenum when the entrance of the bile into the lumen of the duodenum is below the site of obstruction. In pyloric stenosis there is a preliminary progressive gain in weight and maintenance of adequate nutrition, whereas in duodenal obstruction the progress from birth is in general one of rapid deterioration. Finally roentgenograms of the abdomen, both plain and with the aid of contrast media (lipiodol), will aid in making the proper diagnosis.

As an aid in the diagnosis of duodenal atresia, Walz, in 1906, suggested examination of the meconium for lanugo hair and skin remnants. Since these do not appear before the fourth month of fetal life, failure to find them in the meconium would imply a preexisting and complete luminal obstruction. Subsequently Farber in 1933 described a test founded on the same principle. This test is based on the fact that microscopic examination of the smears of normal meconium, when treated with ether, stained with Sterling's gentian violet, and decolorized by acid alcohol, reveals large numbers of cornified epithelial cells which retain the stain. The absence of cornified epithelial cells in microscopic examination of smears of meconium is indicative of congenital atresia of the gastrointestinal tract.

In the newborn the differential diagnosis of atresia, stenosis, and diaphragmatic occlusion of the duodenum is believed of academic rather than of practical importance. However, it has been repeatedly demonstrated that infants with stenoses and perforate diaphragms of the duodenum have survived through childhood and late adulthood without corrective operations. This does not obtain in infants with atresias, severe stenoses, and complete or imperforate diaphragms of the duodenum.

The two most important factors in the treatment of duodenal obstruction in the newborn are early diagnosis and early operation. One cannot be too emphatic in restating the fact that in patients with duodenal atresias, complete stenoses, and imperforate diaphragms the clinical course is one of rapid and

progressive deterioration. These patients withstand the loss of fluids poorly and even in their optimum state one may not consider them good surgical risks.

In obstructive anomalies of the duodenum, the type of corrective operation is dependent upon the type of anomaly that is present. In duodenal atresia one of three operations may be selected (Plate 117 A, *a 1 a 2, a 3*) (1) duodenoduodenostomy (2) duodenojejunostomy or (3) gastrojejunostomy It may be of interest to note that the first successful operation for duodenal obstruction in the newborn was a side-to-side duodenoduodenostomy performed by Fockens in 1911 for an atresia of the duodenum If a direct anastomosis is not feasible a duodenojejunostomy is preferred. Ernst, in 1916 employed an antecolic duodenojejunostomy in performing the second successful operation for obstruction of the duodenum, also an atresia. Finally because of technical considerations and/or the critical condition of the patient, a lifesaving gastrojejunostomy preferably antecolic, may be done. A retrocolic gastrojejunostomy was used by Richter in performing the third successful operation for congenital obstruction of the duodenum. The obstruction was due to stenosis. The main objection to a gastrojejunostomy is that vomiting may persist with varying degrees of severity because of the regurgitation of the blocked duodenal contents into the stomach. This obtained in the infant reported by Sweet and Robertson (1927) upon whom the fourth successful operation was performed for obstruction of the duodenum. Ladd (1937) reported a similar experience in an infant upon whom a posterior gastrojejunostomy was performed for a duodenal obstruction.

In the treatment of stenosis of the duodenum, the same operations as described may be employed. However an antecolic duodenojejunostomy is preferred (Plate 117 B *b1*).

In the surgical management of diaphragmatic occlusions of the duodenum, three other operations, in addition to the three previously described, are available. In two the operative approach is direct and in one it is indirect. The one of choice, from both the theoretical and practical viewpoints, consists of a duodenotomy and excision of the diaphragm (Plate 118, A — Morton).

A second type of direct approach is based on the principle of a Horsley pyloroplasty (Plate 118 B — Peterson). A longitudinal incision is made in the duodenum across the diaphragm, and a transverse closure of the incision is performed.

In utilizing the direct method for either excision or incision of the diaphragm, one must remember that both the bile and the pancreatic ducts frequently course within the membrane. In the perforate diaphragms the ducts frequently open at the margin of an eccentrically placed orifice. Accordingly the use of sutures, particularly the continuous type, to control bleeding from the cut margins of the diaphragm may endanger the patency of the ducts.

Finally a duodenoduodenostomy the indirect approach, may be performed.

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MALROTATION OF THE COLON AND VOLVULUS OF THE MIDGUT

This patient, a full term Negro female infant whose birth weight was five pounds, eight ounces, was seen in surgical consultation 36 hours after a normal spontaneous delivery because of rectal bleeding. On examination the infant was listless and moderately dehydrated but in no acute distress. The abdomen was soft and no masses or viscera were palpable. On digital rectal examination there were no abnormal findings. On the second day following birth, vomiting shortly after each feeding was observed. However there was no recurrence of rectal bleeding. Because of the persistent vomiting a roentgenographic study following the ingestion of a thin barium mixture was obtained. This showed evidence of partial obstruction in the mid-descending portion of the duodenum with moderate stasis proximally. A diagnosis of intrinsic obstruction of the duodenum caused by diaphragmatic occlusion was made and operation was advised. An alternate diagnosis was annular pancreas. The findings at the time of abdominal operation and the operative procedures performed are illustrated.

This particular case serves to emphasize the fact that when an exploratory laparotomy is performed in the newborn for an obstruction of the duodenum, one should always suspect an occult intraluminal obstruction even though there are specific factors (*malrotation of intestines and peritoneal membranes*) to account for the clinical manifestations present.

A. The right paramedian muscle retracting (lateral) incision employed is indicated by the solid black line

B. In this patient, because of the primary preoperative diagnosis of an intrinsic obstruction of the duodenum due to a diaphragmatic occlusion, the incision is made in the mid-descending portion of the duodenum, as denoted by the linear dotted line. This incision overlies the site of the obstruction depicted by the preoperative roentgenograms. The "transverse" colon depicted was subsequently shown to be the ascending colon.

C. The incised margins of the duodenum are secured by guy sutures of silk (000) and retracted transversely. The exploration of the lumen of the duodenum at the site of the duodenotomy failed to reveal an occluding diaphragm. A catheter (No 12 F) was then inserted to determine the patency of the duodenum distally

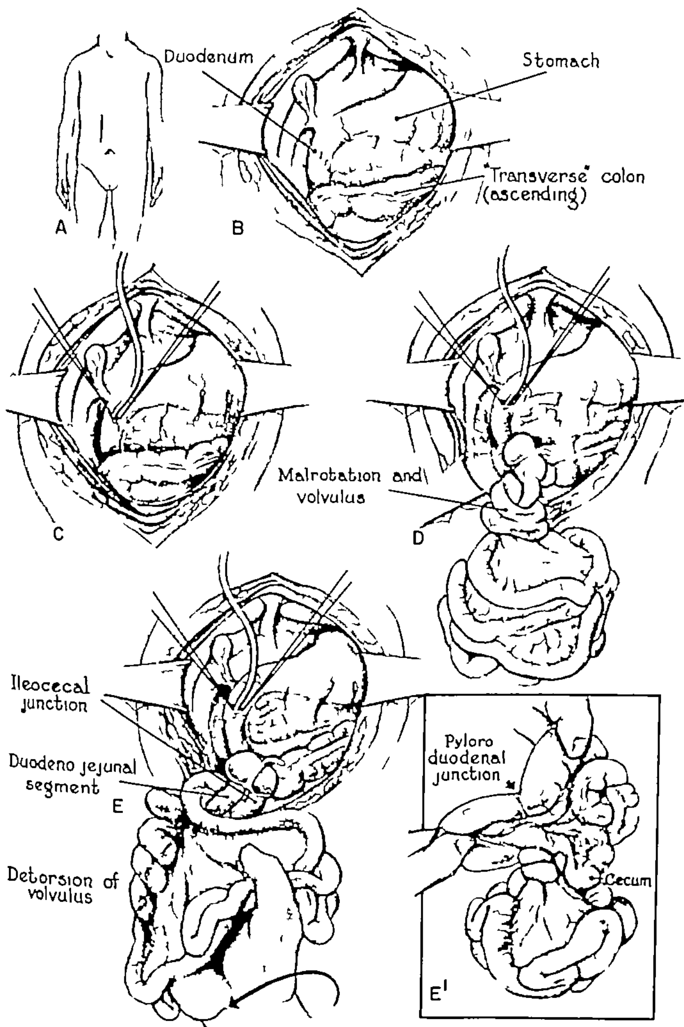
D. Despite repeated attempts the catheter could not be inserted beyond a distance of 5 cm. It was then decided to expose the ligament of Treitz and determine the cause of the intervening obstruction. In doing this the malrotation of the colon and the volvulus of the midgut about its mesenteric vascular stalk were demonstrated. The volvulus of the midgut adequately explained the presenting but temporary symptom of rectal bleeding. The dotted line indicates the site of severance of the peritoneal membrane between the cecum and the posterolateral abdominal wall.

E. Detorsion (anticlockwise) of the volvulus is being performed. The relation of the ileocecal junction to the duodenojejunal segment is visible

E[1] Inset to show an artist's illustration made from a photograph of the findings at operation in another newborn in whom volvulus of the midgut (clockwise rotation) with duodenal obstruction and reversible compromise of the circulation of the greater portion of the midgut was present

Discussion—Dr. Thomas V Santulli. The history in this infant is highly suggestive of intestinal obstruction due to malrotation with midgut volvulus. In a small percentage of these cases, the presenting symptom may be the passage of dark red blood by rectum. If this is accompanied or followed by bile stained vomiting, duodenal obstruction from midgut volvulus is probably the underlying cause. The bleeding results from venous stasis in the small intestine and is probably indicative of pressure on the superior mesenteric vessels at the base of the volvulus. The great danger lies in occlusion of these vessels with ensuing gangrene of the entire midgut segment. If the diagnosis is suspected, plain three-position x-rays of the abdomen may reveal distention of the stomach and duodenum with a normal distribution, or a small amount, of air in the small intestine below. A barium enema will show malrotation of the colon and serves to confirm the diagnosis. It is rarely necessary to give a contrast agent orally for a gastrointestinal series in this type of case; however, with intermittent, low grade obstruction it may be necessary.

Once the diagnosis is suspected and there has been blood passed by rectum, immediate operation should


Duodenum
Stomach
"Transverse" colon
(ascending)
A
B
C
Malrotation and
volvulus
D
Ileocecal
junction
Duodeno jejunal
segment
E
Detorsion of
volvulus
Pyloro
duodenal
junction
Cecum
E'

F The detorsion of the volvulus is completed, and the recommendation of Ladd to leave the duodenum on the right side and the ileocecal and cecoascending colon segments on the left side is followed

G The catheter is withdrawn and the linear incision in the duodenum is closed in a horizontal plane using two layers of interrupted silk (0000) sutures

H After the operation illustrated, obstructive symptoms remained manifest and a gastrointestinal series following a barium meal was repeated. The roentgenograms again showed evidence of duodenal stasis and partial obstruction in the region of the mid descending portion of the duodenum Four days following the first operation a second abdominal exploration was performed. The incision in the duodenum was reopened and on attempting a retrograde passage of the catheter (12 F) into the stomach an obstruction within a distance of 3 cm was observed. A second incision was then made in the anterior wall of the antral region of the stomach through which a second catheter was inserted toward the opening in the duodenum. Similarly an intraluminal duodenal obstruction was present at approximately the same level as previously noted on retrograde passage of the catheter through the duodenal incision.

I J K. The catheters were withdrawn and a curved (Kelly) clamp was inserted through the gastric incision into the lumen of the duodenum. In so doing there was a sudden "give" felt through the clamp which then passed easily through the duodenal incision (I) In performing this maneuver no undue force was used. In fact the ease with which the obstruction was relieved made one doubt the existence of a typical intraluminal diaphragm with mucous membrane covering on either side. Instead it felt as if a thin veil of tissue was broken through Subsequently the catheter (No 12 F) was inserted through the gastric opening into the lumen of the duodenum to a level beyond the incision in its mid-descending portion. The incisions in the stomach and duodenum respectively were then closed in two layers using interrupted sutures of silk (0000) (J). The closure of the gastric incision was made about the catheter which was subsequently brought through the line of closure of the abdominal incision (K) The catheter was removed on the seventh day after operation, and the recovery of the patient was without incident.

DISCUSSION—DR. SANTULLI (cont.)

be done. The incision shown in Plate 120 A, is probably too small for adequate exposure. When operating for intestinal obstruction in infancy a long paramedian incision or upper transverse incision is necessary in order to adequately visualize the pathology In cases of malrotation or other forms of neonatal obstruction, it is mandatory to eviscerate all of the small intestine in order to be able to adequately visualize the pathology

The midgut volvulus illustrated in Plate 120, D and E, is the usual form found in this age group The volvulus is almost always in the clockwise direction, and reduction is accomplished by turning the bowel in the counterclockwise direction In some cases there have been four complete turns of the intestine

After reduction of the volvulus, the commonly associated congenital peritoneal bands should be divided so that the duodenum is completely freed. In Plate 121 F the duodenum is seen to lie entirely on the right side as in the usual case and the cecum will come to lie in the left lower quadrant when it is completely freed If all of the peritoneal bands are freed, it is not essential to fix the cecum to the right lower quadrant, although some surgeons prefer to do this

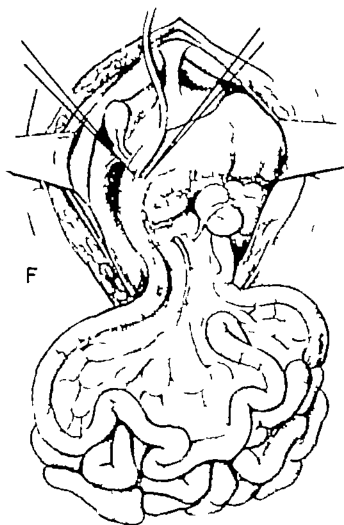
The question of intrinsic duodenal obstruction associated with malrotation and midgut volvulus is interesting Undoubtedly a certain percentage of cases of malrotation with midgut volvulus have an associated stenosis (diaphragm) of the duodenum

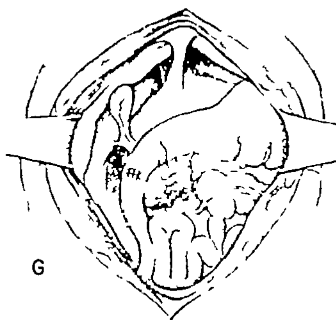
In Plate 120 B and C, the incision in the duodenum did not disclose a diaphragm which apparently existed in this particular case. If the surgeon suspects intrinsic duodenal obstruction, after having reduced the volvulus and divided all of the congenital peritoneal bands, it is probably best to open the stomach and pass a catheter down the duodenum in order to find a diaphragm. Some pediatric surgeons routinely perform this maneuver in all patients with malrotation after having reduced the volvulus. This may be a wise precaution before terminating the procedure. A small opening made in the stomach in order to pass a catheter down the duodenum to rule out the presence of a diaphragm adds very little to the procedure.

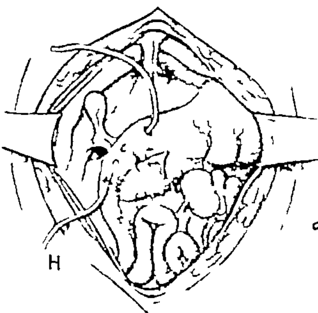
The intrinsic obstruction which was missed at the first operation was found at the second operation by the maneuvers depicted in Plate 121 H and I. The clamp apparently perforated a duodenal diaphragm and cleared this part of the obstruction. The catheter shown in Plate 121 J seems to be a wise precaution in such a procedure

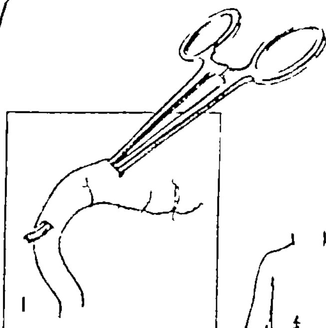
It should be pointed out, however that these diaphragmatic types of obstruction anywhere in the intestinal tract are very rarely successfully treated by perforation of the diaphragm with a clamp or by any other type of plastic procedure which directly attacks the occluding membrane It is always preferable to perform an anastomosis above and below the level of the diaphragm

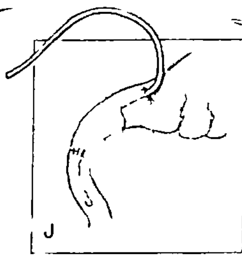
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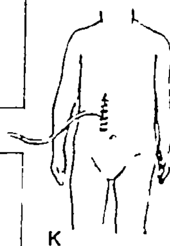

F


G


H


I


J


K

EXCISION OF DUODENAL DIVERTICULA

A, B. The peritoneal cavity is entered through an upper right rectus paramedian muscle-retracting (lateral) incision (A), and the underlying intraperitoneal viscera are visible (B)

C. The severance of the right phrenocolic ligament preparatory to mobilizing the hepatic flexure is indicated by the dotted line.

D The site of the incision (Kocher) in the posterior parietal peritoneum prior to mobilizing and rotating (Moynihan rotation maneuver) the duodenum toward the midline is depicted (dotted line).

E. The mobilized duodenum is secured in Babcock clamps and rotated toward the midline. A traction guy suture of silk is inserted in the apex of the partially mobilized perivaterian diverticulum, and as traction through the suture is maintained, the fibroareolar tissue attachments of the diverticulum to the posterior aspect of the head of the pancreas and the neighboring structures are severed by scissor dissection.

F The mobilization of the diverticulum located in the second portion of the duodenum at the level of the papilla of Vater (perivaterian) is completed, and its relation to the surrounding structures is visible. The diverticulum is secured by two clamps (Babcock) preparatory to opening into its lumen by scissor dissection.

Diverticula of the duodenum may be conveniently classified as primary and secondary Primary diverticula occur most commonly in the region of the papilla of Vater (perivaterian) Less frequently they are located in the third and fourth portions of the duodenum. Primary duodenal diverticula are all false in that they do not contain all the coats of the bowel wall The mucosa is herniated at its mesenteric border between the fibers of the muscle layers and is covered only by a thinned out serosal layer When completely mobilized, the wall of the summit of the diverticulum is usually thin and transparent and frequently exhibits a multiloculated appearance. In fact, the wall of the summit of the diverticulum may be readily torn by a Babcock clamp even though lightly applied.

Secondary diverticula, as the name implies, are generally secondary to a chronic duodenal ulcer These are true diverticula in that they contain all the layers of the wall of the duodenum. They are located on the inferior (mesenteric) border of the first portion of the duodenum at a site opposite a cicatricial duodenal ulcer

Primary or false, diverticula are most commonly asymptomatic, and surgical treatment is not indicated. However in some instances a diverticulum may be the basic cause of the patient's complaints and accordingly operation is advised. The main indication for operation is abdominal pain persistently localized over the site of the diverticulum and associated with local, deepseated tenderness in the same area. Furthermore, the absence of concomitant disease in the stomach, duodenum, or biliary tract should be demonstrated. A prolonged retention of barium within the diverticulum is in itself not considered an indication for operation. In the 11 patients operated upon to date in whom duodenal diverticula were excised the results have been satisfactory There were no complications, such as wound infection or duodenal fistula, and there were no operative deaths.

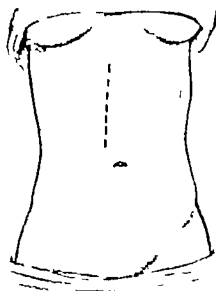
The treatment of secondary or true, diverticula is the treatment of the primary cause, namely chronic cicatricial duodenal ulcer

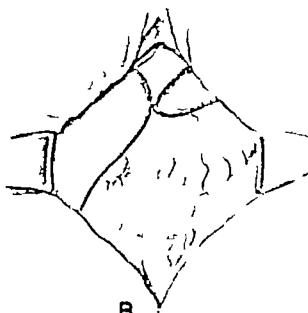
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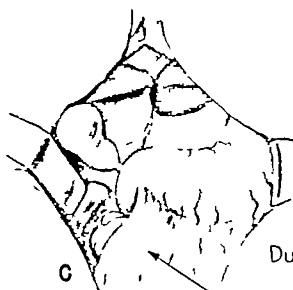
Discussion—Dr Russel H Patterson For the patient with a long narrow abdomen and long slanting ribs, we prefer a vertical muscle-splitting or muscle-retracting incision. The subcostal or oblique incision is used for the short broad abdomen We have found the vertical incision more comfortable postoperatively for the patient, and also, if drainage is necessary a lateral stab wound is easily made permitting primary closure of the operative wound.

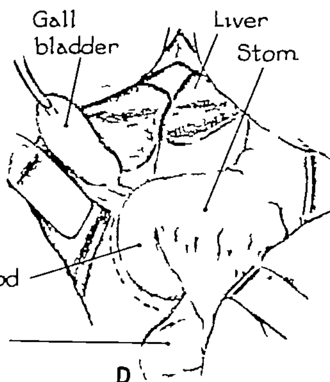
Upon opening the abdomen the surgeon has two immediate observations to make First, since with the majority of diverticula which produce symptoms there are other lesions present, these lesions must be carefully examined and their status in the symptom complex determined Second, the duodenal diverticulum itself must be exposed and its relation to surrounding structures must be defined. Since these diverticula are often multiple, a decision has to be made as to the treatment of each one. Duodenal diverticula may be very difficult to find. It is helpful to appreciate, however that the great majority of primary diverticula are in the second portion of the duodenum and often near the ampulla of Vater To identify the diverticulum, the duodenum may be inflated or bismuth may be given by mouth prior to operation.

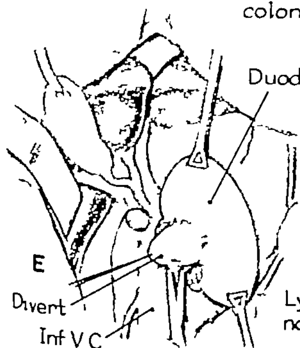
For most diverticula quite satisfactory exposure is obtained by mobilizing the duodenum as shown (Plate 122, C F). For exposure of those diverticula in the third part of the duodenum the transverse colon is elevated and the peritoneum over the duodenum is opened between the midcolic and the superior mesenteric arteries. The ligament of Treitz may be carefully divided if necessary (*Plate 124, R, S*). *In exceptional circumstances it may be necessary to open the duodenum and feel for the diverticulum*

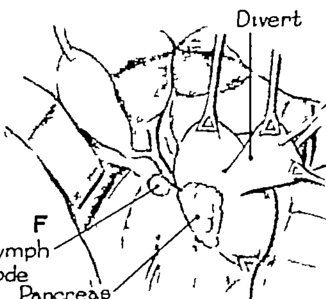

A


B


C


Gall
bladder
Liver
Stom
Duod
Trans
colon
D


Duod
E
Divert
Inf V C


Divert
F
Lymph
node
Pancreas

G. Traction is applied through the clamps (Babcock) on the cut margins of the diverticulum, and its posterior wall is severed longitudinally to the level of junction with the lumen of the duodenum This technic is similar to that used in the excision of the redundant portion of a hernial sac.

H. Similarly the anterior wall is incised, and the resultant flaps formed are severed at their bases in an elliptical manner as indicated by the dotted line This method of excising a diverticulum ("open" technic) is preferred because one may have under constant surveillance the papilla of Vater which may frequently be in an abnormal position in relation to the neck of the diverticulum. It is also preferred to occlusion of the neck of the sac by the "blind" insertion of a transfixion suture ligature which is believed a peril to the patency of the papilla of Vater and to inversion of the diverticulum into the lumen of the duodenum.

I. The excision of the diverticulum is completed and the relation of the cut margins of the duodenum to the papilla of Vater is readily seen.

J. The first of a two layer closure of the opening in the wall of the duodenum is begun. The sutures (0000 silk) are inserted from the "inside out" to the "outside in" so that, when tied the knots are on the inside of the lumen.

K. The sutures are inserted from either end toward the center of the line of closure where the last two sutures inserted are encircled by an untied reinforcing figure of 8 mattress suture of silk (000)

L. The figure of 8 mattress suture is tied and cut, and the interrupted mattress sutures (Halsted) of 000 silk which comprise the second layer of the closure are inserted but not tied.

M. The Halsted mattress sutures are tied and the long ends cut to complete the excision of the diverticulum of the second portion of the duodenum. Attention is drawn to the shiny serous coat covering the second portion of the duodenum. All too frequently artist's illustrations show incorrectly a "bare" area, as if devoid of serosa, in the second portion of the duodenum corresponding to the area which is overlain by the colon. This portion of the duodenum is commonly referred to as the retroperitoneal rather than the retrocolic portion which is the preferred term. In fact, embryologically the duodenum is no more retroperitoneal than the stomach or the rest of the small intestines.

DISCUSSION—DR. PATTERSON (cont.)

with the fingers. In such cases it is sometimes possible to invaginate the diverticulum and remove it from the inside of the bowel.

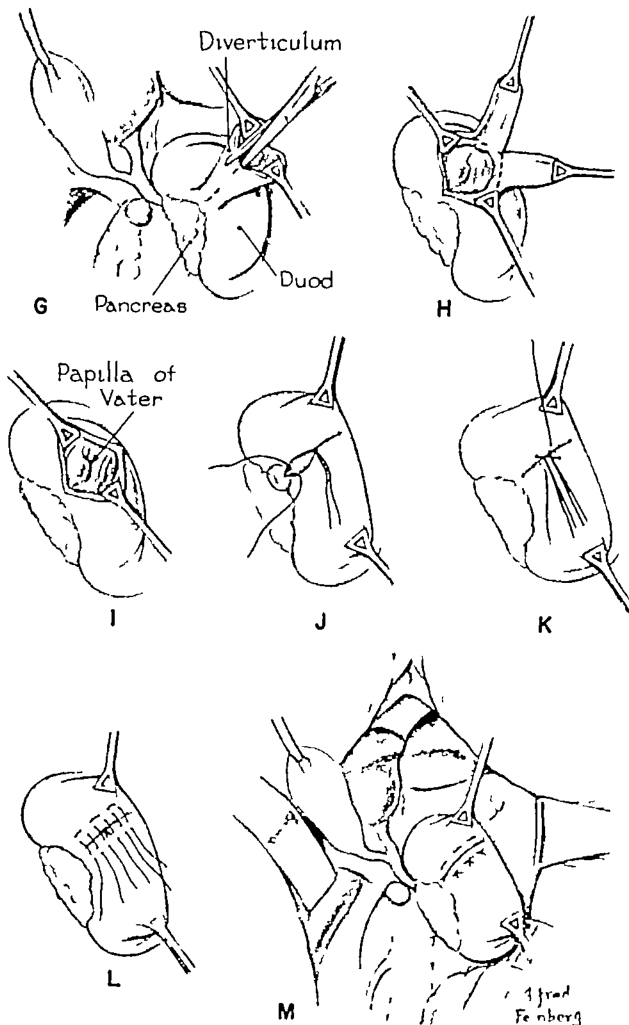
In removing a perivaterian diverticulum one has to be certain about the integrity of the ampulla of Vater The following maneuvers are helpful to this end The common duct may be catheterized, the ampulla may be inspected through the stump of the excised diverticulum a separate opening may be made in the duodenum.

When the duodenum is opened, unless the common duct has been catheterized, it is not an easy matter to immediately identify the ampulla. Though some anatomy books state that the ampulla is 7.5 to 10 cm. from the pylorus, in a series of studies we found that the ampulla was more nearly 10 cm. from the pylorus in every case. Pressure on the gallbladder will often force bile out of the ampulla. The ampulla is slightly elevated, and the duodenal transverse rugae curve up over the ampulla in such a manner as to simulate a frenum.

Though a diverticulum may be inverted it is rather generally agreed that excision is the procedure of choice Plate 123 shows the method of excision. We never clamp the base of the neck of the diverticulum. We try to leave a cuff of mucosa which we close with fine catgut sutures following with interrupted single or mattress sutures in the outer bowel layers.

Following excision of a diverticulum, drainage is rarely necessary but if there is any doubt about the integrity of the duodenal closure we would not hesitate to place a cigarette drain to the site and bring it out through a stab wound lateral to the abdominal incision.

The clinical evaluation of the radiographically established diverticulum, in relation to the symptoms, presents a difficult problem. However when the diverticulum is the offending agent in one or more of the following complications, surgery is required (1) obstruction of bile or pancreatic ducts with jaundice or pancreatitis (2) obstruction of duodenum with partial or complete blocking (3) inflammation in the form of diverticulitis, ulcer perforation, or enterolith formation, (4) neoplastic change with leiomyoma or carcinoma developing in the diverticulum, (5) hemorrhage, small or massive, resulting from ulcer or breaking of thin walled capillaries or blood vessels


Diverticulum
Duod
G
Pancreas
H
Papilla of
Vater
I
J
K
L
M

This plate depicts the various locations of duodenal diverticula demonstrated by the surgeon to the artist at the time of operation.

N The whole of the duodenal loop is mobilized to show a diverticulum at the angle of junction of the second (descending) and third (horizontal or transverse) portions of the duodenum.

O The apex of the diverticulum is grasped in a Babcock clamp and with upward traction through the clamp maintained, it is severed from the surrounding attachments by scissor dissection as depicted.

P The completely mobilized diverticulum is secured in Babcock clamps (two), and with scissors it is bisected from the apex to the base as indicated by the dotted line. The respective halves are elliptically excised at their bases, as previously shown (H).

Q This is a demonstration of a partially mobilized perivaterian diverticulum in which intrapancreatic dissection was required for its removal.

R. This illustration depicts a diverticulum of the fourth portion of the duodenum underlying the base of the transverse mesocolon. Its relation to the ligament of Treitz and the superior mesenteric vascular stalk is visible. The incision in the serosal covering of the transverse mesocolon overlying the diverticulum is indicated by the curved dotted line.

S. The serosa covering of the base of the transverse mesocolon is incised and the diverticulum is mobilized. The resection of the diverticulum and the closure of the opening in the duodenum proceeds as previously demonstrated (F–M).

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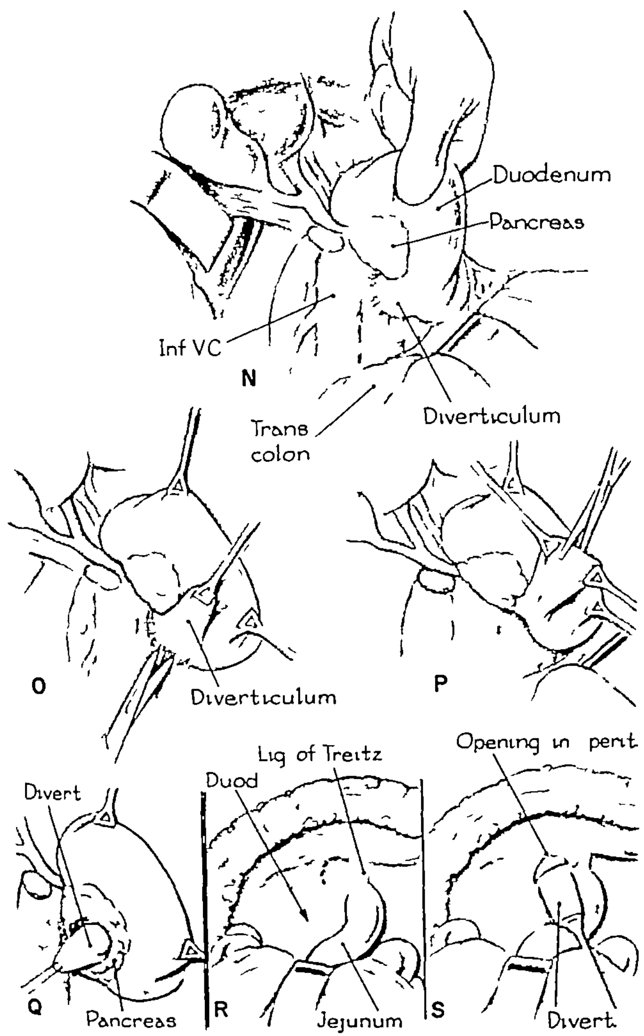
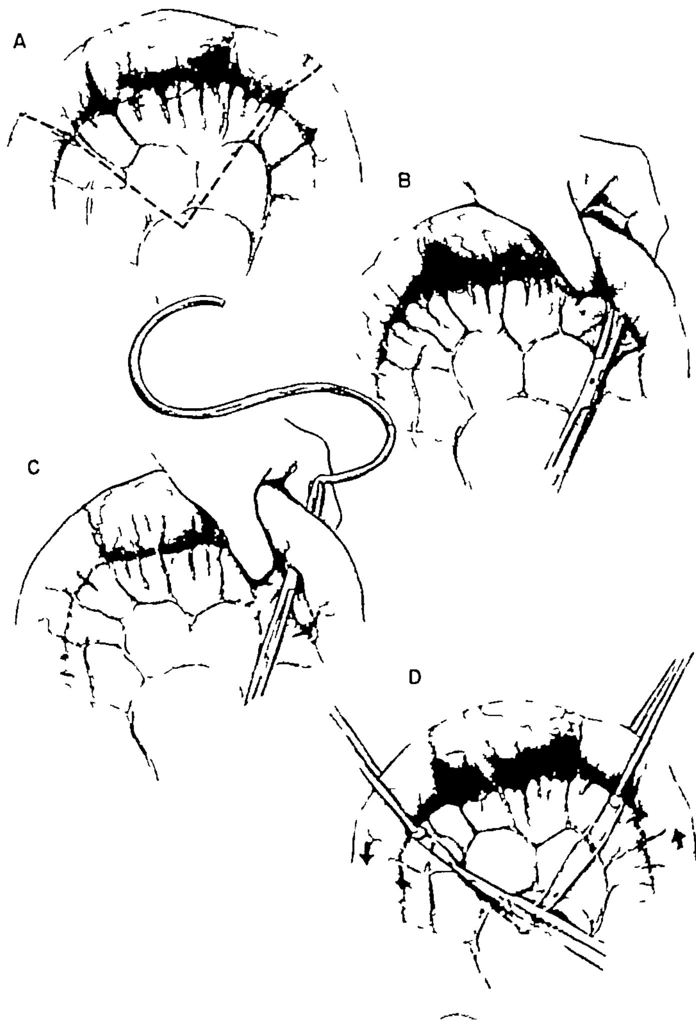

Duodenum
Pancreas
Inf VC
N
Trans
colon
Diverticulum
O
Diverticulum
P
Divert
Lig of Treitz
Duod
Opening in perit.
Q
Pancreas
R
Jejunum
S
Divert.

Plate 125

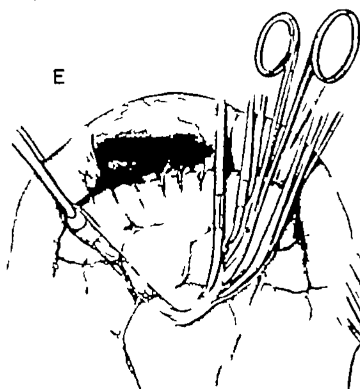


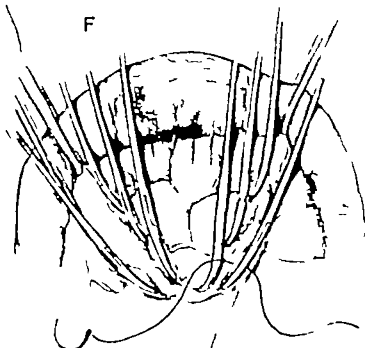
E, F The mesentery is serially clamped and severed by scissor dissection (E) and hemostasis is obtained with suture ligatures of 000 silk (F) In the application of clamps to the mesentery small bites of tissue should be taken and the clamps tightly locked to prevent slipping and resulting hemorrhage In fatty areolar tissue, suture ligatures are used routinely for hemostasis.

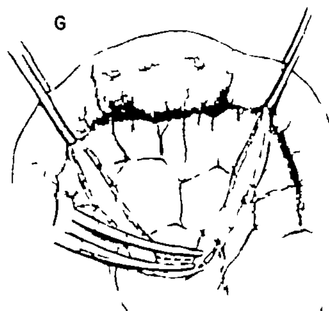
G The clamps on the cut margins of the mesentery of the bowel that is to remain are replaced by suture ligatures of silk (000) and those on the segment of mesentery that is resected are replaced by simple ligatures of silk (000) The remaining attachment of the mesentery is doubly clamped, and its severance is indicated by the dotted line

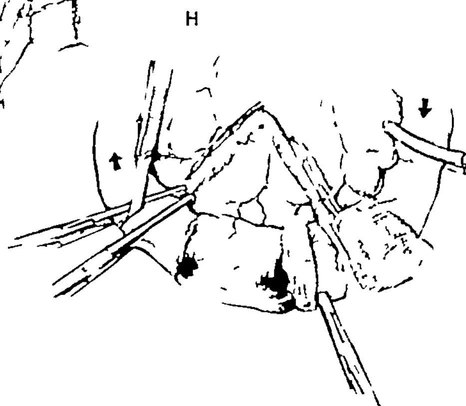
H. Following the completion of the transection of the mesentery and the ligation of its vessels, the operative field is declared contaminated The field of contamination is defined by the use of moist toweling and an appropriately colored (red) laparotomy sheet. The lumen of the bowel proximally is occluded with a rubber covered intestinal clamp and the bowel at the sites of election for its transection is doubly clamped The transection of the bowel proximally is completed, and its severance distally with a scalpel is shown The clamps are applied across the bowel at an approximate 60 degree angle obliquity to assure adequacy of the blood supply to the antimesenteric cut margin. The jaws of the clamps on the cut margins of the small intestine to be anastomosed are held in approximation but not locked. This is done to avoid unnecessary crushing trauma to the tissues.

Plate 126









I. The end to-end "open" anastomosis, the preferred technic, is begun. Prior to the anastomosis, adequacy of the circulation to the cut margins must be assured This is indicated by the occurrence of fresh bleeding from and the healthy appearance of the unclamped cut margins The antimesenteric margins of the transected small intestine are secured in Babcock clamps, and the mesenteric coaptation mattress suture of fine (0000) silk is inserted.

J Similarly a coaptation mattress suture of silk (0000) with its "loop on the mucosa" is inserted for the approximation of the antimesenteric cut margins

K. By traction on the coaptation sutures, the cut margins of the bowel are apposed, and a series of interrupted through and through everting mattress sutures of silk are inserted.

L. The mattress sutures are tied, and the everted layers of the bowel wall are firmly approximated with simple interrupted sutures of fine (0000) silk. Although the use of silk rather than fine (000) catgut for the inner or mucosal layer of the anastomosis is frequently condemned, no difficulty has been observed with its routine use.

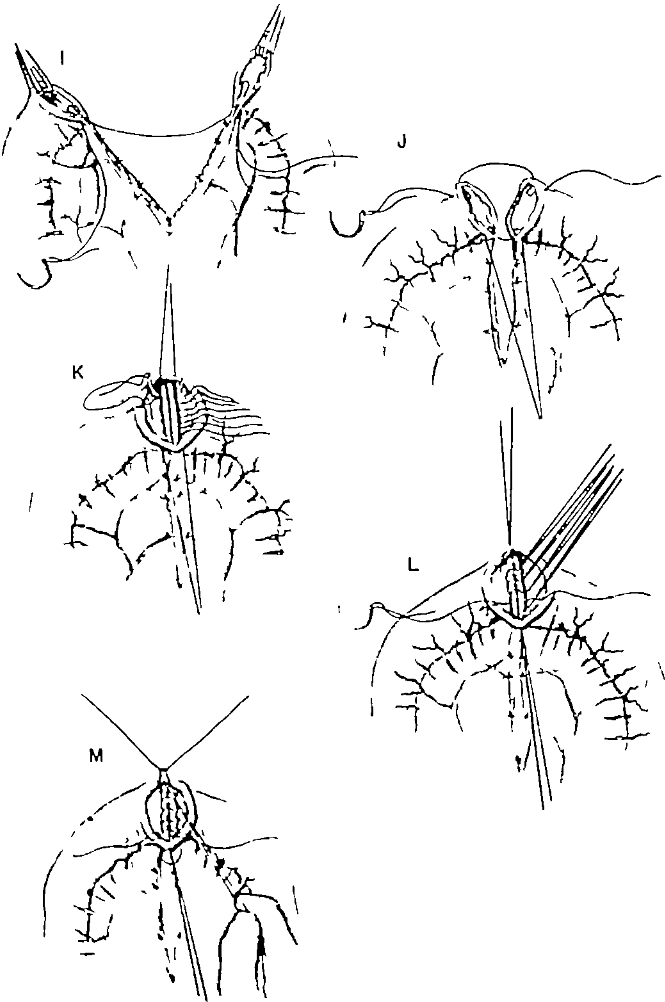
M. The interrupted sutures of silk (0000) are continued anteriorly and are inserted from the "inside out" to the "outside in" so that, when tied, the knots of these sutures are on the inside of the lumen and inversion of the bowel wall is obtained.

Discussion—Dr. John H Eckel The success of an anastomosis, by whatever method, depends on close observance of three fundamental principles of intestinal surgery well defined by Whipple as. (1) the maintenance of an adequate blood supply to the zone of the anastomosis by the careful preservation of the continuity of the blood vessels in the mesentery supplying the zone· (2) the placing of an accurate seromuscular suture to provide an adequate apposition of peritoneum on either side of the suture line· and (3) the prevention of tension on the suture line with its accompanying tissue necrosis. Tension on the suture line can be prevented by the avoidance of tying the sutures too tightly and by keeping the proximal segment of bowel empty of gas and fecal content by some form of decompression. These principles are carefully adhered to in both of the methods which are illustrated.

An "open intestinal anastomosis is always secure and affords the surgeon the opportunity to observe the size of the lumen at the anastomotic site (Plate 127 I M). When a "closed" or "aseptic" anastomosis is carried out (Plate 129), it is of extreme importance to test the patency of the anastomotic lumen as demonstrated (Plate 129 O).

Small bowel resection is performed in many conditions, the most common being the loss of viability due to irreversible compromise of the circulation

Plate 127



N The sutures are inserted alternately from the mesenteric and antimesenteric borders toward the midline to avoid an angle closure. If traction on the previously inserted and tied suture is maintained toward the lumen as each succeeding suture is tied, inversion of the bowel wall is facilitated. The last two sutures have been inserted, and when they are tied, the first layer of the closure anteriorly is completed.

O The last two sutures of the first layer anteriorly are tied and encircled by a reinforcing figure of 8 mattress suture to assure both an air tight and water tight closure.

P Q The second layer of sutures anteriorly, a series of interrupted seromuscular sutures (Lembert), is inserted (P) and continued as an additional reinforcing layer posteriorly (Q).

R_1 In those instances in which a linear circumferential and irreversible compromise of the circulation of the bowel caused by a constricting adhesive band is present, simple inversion by a series of interrupted seromuscular Lembert sutures may be employed. This technic is frequently referred to as the "Sumner stitch."

R S. Traction on the circumferential layer of seromuscular sutures is maintained (R) as each suture is tied to complete the anastomosis (S). The operative field is then declared clean, and after a change of gloves by the surgical team and with a clean set of instruments, the opening in the mesentery is closed using interrupted sutures of fine (0000) silk (S). Wound closure in layers as previously depicted completes the operation.

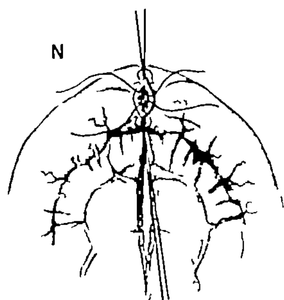
DISCUSSION—DR. ECKEL (cont.)

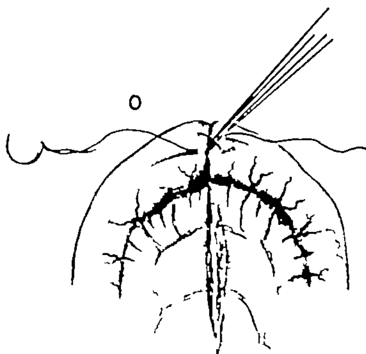
by strangulation. In such instances there is always a marked discrepancy in the size of the distended and obstructed bowel proximally and the collapsed bowel distally. This discrepancy may be so marked that an end-to-end anastomosis is contraindicated, and a side-to-side anastomosis must of necessity be performed. However, this is rare.

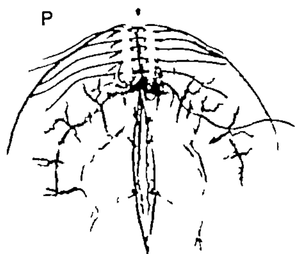
Halsted proposed an aseptic type of end-to-end anastomosis performed over Kocher clamps, and most of his three generations of disciples have continued to employ this method. Although this procedure may be more painstaking than an "open" type of anastomosis, it minimizes contamination by spillage and reduces the incidence of wound infection. In our experience postoperative peritoneal hemorrhage has not been a complicating factor.

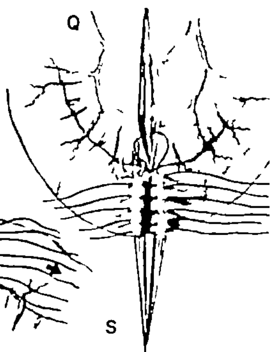
The method described in Plate 129 (aseptic end-to-end anastomosis) is the one first worked out experimentally by Halsted and has proved satisfactory to a large group in the Department of Surgery at the New York Hospital. Person and O'Neill described a method to compensate for the disparity between the dilated proximal and collapsed distal loops by applying the distal clamps in an oblique manner. This is facilitated by employing calibrated Kocher or Allen clamps. When an "open" end-to-end anastomosis is performed, the disparity is less troublesome.

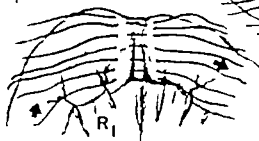
Finally, in rare instances where there is extreme disparity in the size of the loops of bowel, one may feel more secure by performing an "open" side-to-side anastomosis. In this type of anastomosis it is important that no proximal jejunum or ileum be allowed to extend distal to the anastomosis, since such a pouch may perforate or become gradually enlarged and produce symptoms of indigestion, abdominal pain, and distention.

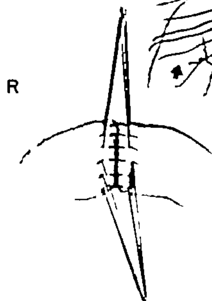

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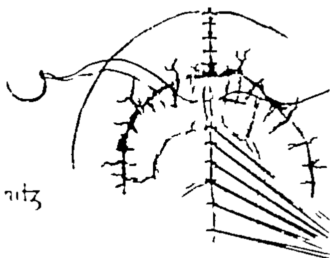

O


P


Q


R_1


R


S

SEGMENTAL RESECTION OF THE SMALL INTESTINE AND "ASEPTIC" END TO END ANASTOMOSIS

Although this technic is a rapid and effective method for the performance of an end to-end anastomosis, the "open" technic is preferred. The hazards of this method are (1) hemorrhage (2) inversion of an excessive amount of tissue with the formation of an obstructive diaphragm

A. The bowel on either side of the segment to be resected is doubly clamped, and the sites of transection of the bowel and its subjacent mesentery are indicated by the dotted lines.

B, C. The segmental resection of the small intestine is completed (B) and with the occluding clamps firmly locked and carefully approximated a series of interrupted seromuscular mattress sutures of silk (000) are inserted anteriorly (C).

D The handles of the clamps are turned downward to rotate the bowel 180 degrees on its longitudinal axis, and a series of interrupted seromuscular mattress sutures of silk (000) are inserted posteriorly

E. Traction is maintained on the circumferentially placed, interrupted seromuscular mattress sutures as the clamps are carefully and slowly withdrawn.

F The mattress sutures are tied, and the opening on the antimesenteric surface of the bowel through which the clamps were withdrawn is closed with a seromuscular mattress suture of 000 silk

G The "aseptic" anastomosis is completed, and the opening in the mesentery is closed By digital manipulation the agglutinated cut margins of the bowel are separated and its lumen is restored. The importance of this maneuver in the avoidance of postoperative intestinal obstruction cannot be overemphasized. Furthermore careful inspection of the line of anastomosis, particularly along its mesenteric aspect, should be done to be sure that there is no leakage.

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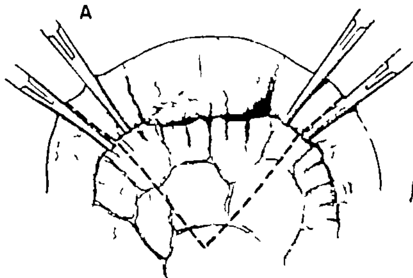
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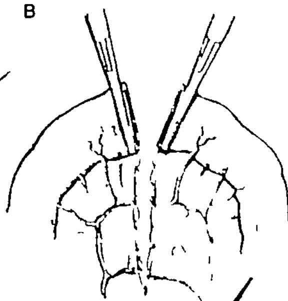
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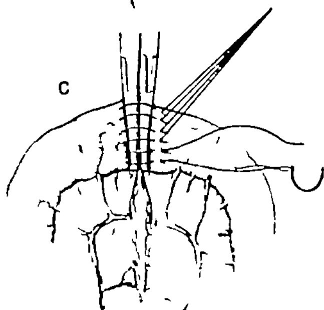
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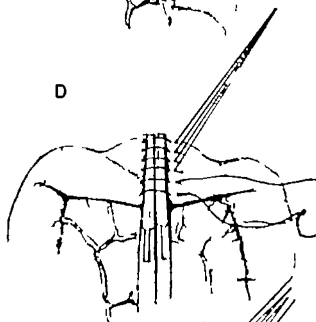
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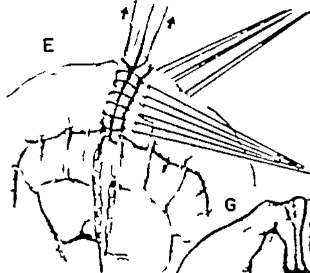
Plate 129

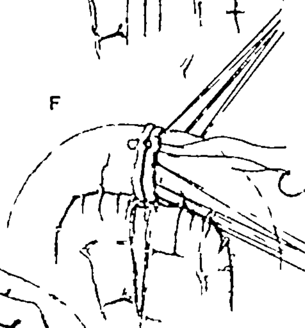


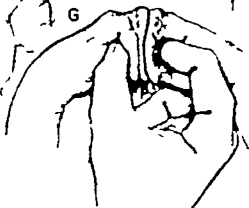












ILEO ENTECTROPY

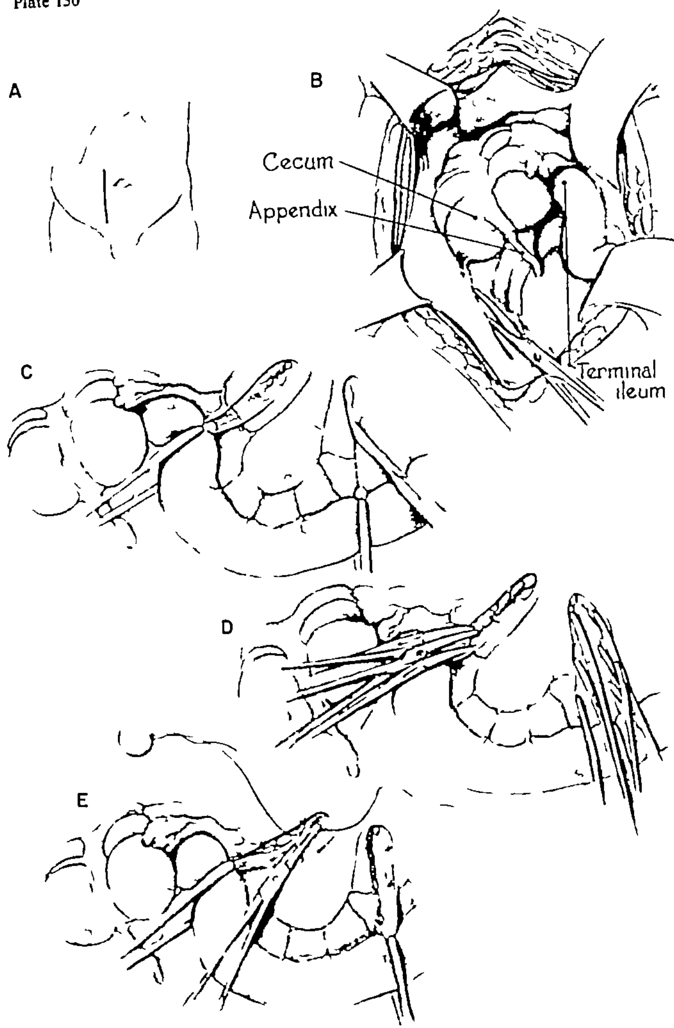
The title for this operation, ileo-entectropy is derived from the Greek [ileo (εἰλεός), terminal part of small bowel, + ent (ἐντός) inside, + ec (ἐκ), outside, + tropy (τρόπος) a turning], meaning to turn the ileum inside out. The operation, originated by Charles G Neumann of New York, was first used in the experimental animal in the treatment of ascites produced by partial occlusion of the thoracic segment of the inferior vena cava. The experimental results obtained encouraged the employment clinically of ileo-entectropy in a small select group of patients with intractable ascites. At the present writing a positive opinion cannot be formulated relative to the therapeutic efficacy of this operation because the number of patients operated upon is too small and the period of follow up is too short. The inclusion in the Atlas of the technic for the performance of ileo-entectropy is on the basis of the interest which it has provoked and its originality However one cannot emphasize too strongly the fact that the merits of this particular operation remain to be proved

A. The right lower paramedian muscle-splitting incision is outlined.

B. The peritoneal cavity is entered, and the incision in the posterior parietal peritoneum below the cecum is begun by scissor dissection.

C, D E. The terminal ileum is encircled by catheters (No 12 F) at the sites for its transection proximally and distally and, with a scalpel, directional lines for the application of clamps are made through the serosa of the mesentery of the small bowel (C). The mesentery is serially clamped and severed (D), and hemostasis is obtained with suture ligatures of silk (000) as each clamp is removed (E).

Plate 130



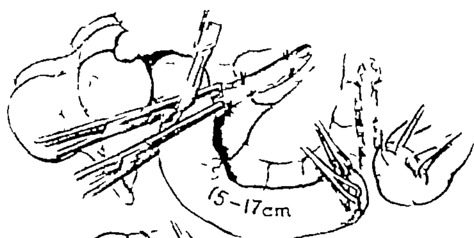
F The transected ends of the ileum proximally are occluded with Babcock clamps, and, with a scalpel, the transection of the ileum distally is being completed between clamps. The jaws of the clamps are approximated but not locked to avoid crushing trauma to the tissues.

G The transection of the ileum both proximally and distally is completed and a segment 15 to 17 cm. in length, attached by its mesentery is isolated.

H. The end to-end anastomosis anterior to the isolated segment of ileum is begun by first inserting the mesenteric and antimesenteric approximation sutures.

I. The insertion of the first posterior suture layer a series of interrupted everting mattress sutures, is completed. For technical expediency the sutures are all first inserted before being tied.

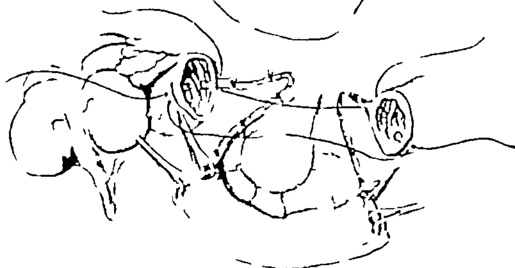
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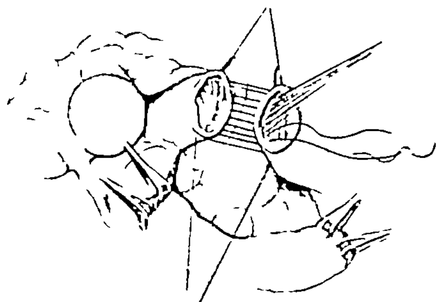
G



H



I



J The approximating angle sutures and the first posterior layer of mattress sutures are tied, and the long ends are cut. The insertion of the second posterior layer, a series of interrupted silk (000) sutures, is being completed.

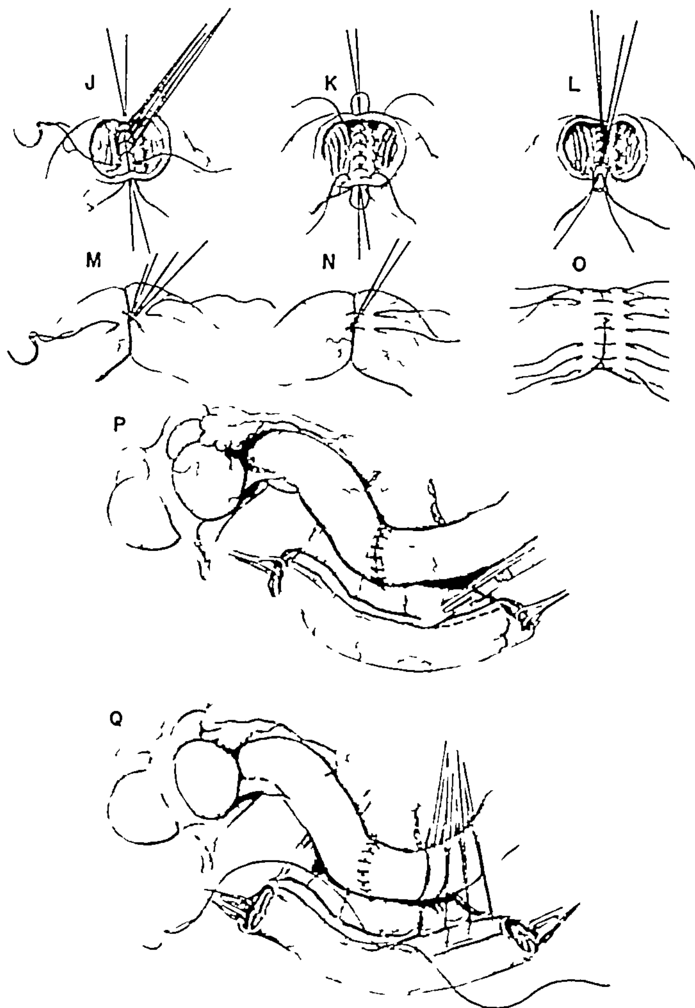
K L. The two layer closure posteriorly is completed, and the insertion of the first layer of sutures anteriorly is begun (K). This layer consists of a series of interrupted inverting sutures of silk (000) which are inserted from the "inside out" on one side and from the "outside in" on the other so that, when tied, the knots of the sutures are on the inside of the lumen. To facilitate the inversion of the anterior layer traction medially is maintained on the previously inserted suture as the succeeding suture is tied (L).

M. The sutures are inserted alternately from either side and terminate in the midline anteriorly at which point the closure is reinforced by a figure of 8 mattress suture of silk (000)

N O The second layer of sutures anteriorly is inserted This layer consists of a central seromuscular mattress suture (N) and a series of simple interrupted seromuscular sutures (Lembert) of silk (000) on either side (O).

P The end to-end "open" anastomosis is completed, and the incision through the serosal layer of the isolated segment of the terminal ileum close to its mesenteric border is being made

Q The incision in the serosal layer is made, and the vessels in the submucosal layer are being undersewn with hemostatic suture ligatures of silk (0000)


J
K
L
M
N
O
P
Q

R. Two rows of hemostatic suture ligatures are inserted, and the opening into the lumen of the ileum is being made by scissor dissection.

S. An incision is made through the full length of the bowel wall of the isolated ileal segment, and one of its cut margins is being approximated to the lateral cut margin of the incision previously made in the posterior parietal peritoneum.

T. The ileo-entectropy is completed, and its relation to the adjacent intraperitoneal viscera is visible.

DISCUSSION—DR. CHARLES GEORGE NEUMANN: The operation of ileo-entectropy was designed to permit the intestinal mucosa to absorb excess fluid such as occurs in ascites of any origin (cirrhosis, nephrosis) or in hydrocephalus. Clinical trials in cirrhotics with ascites have demonstrated the ability of the mucosa to function effectively, but it can not be stressed too strongly that, in the use of ileo-entectropy for ascites, the patient's general condition must be such as to permit him to survive the trauma of the necessary surgical and anesthetic experience. Usually the very condition, namely intractable ascites, for which the operation may be beneficial, has imposed such a drain on the patient's resources that every effort must be made to qualify the patient as a surgical risk and to support him during the postoperative period.

With an understanding of the principles involved in ileo-entectropy for ascites, quite a series of modifications of the operation can be devised. Basic to any modification are sterilization of the bowel to avoid peritonitis, omentectomy to guard against encapsulation of the opened segment by the omentum, provision to minimize danger of rupture of esophageal varices (in cirrhotics) as by prolonged use of a Levin tube, and attachment of the serosa of the opened segment (in cirrhotics) to the parietal peritoneum to permit development of anastomoses between the portal and parietal circulations.

There is no valid reason for using one segment of ileum in favor of another except that surgical expediency suggests the use of the terminal ileum. Instead of reestablishing intestinal continuity by end-to-end anastomosis of the ileum, it is possible to discard the cecum and ascending colon and perform an ileo-colostomy. In this way a large area of the posterior parietes is made available for reception of the serosa of the opened ileal segment.

As for the length of segment to be opened, little can be said. Obviously, the longer the segment, the more fluid can be absorbed but also the surgical problem of placing the segment to advantage is greater. A length of 15 to 17 cm. should be adequate except in those few patients who produce prodigious quantities of ascitic fluid.

Theoretically, the possibility of the continued production of mucus by the exposed mucosa could lead to the accumulation of a disturbingly large quantity of mucus within the peritoneal cavity. Apparently mucus is secreted in very small amounts for several weeks after operation, but both in experimental animals and in patients (who have been observed up to one and one half years without abdominal distention), the secretion of mucus ceases.

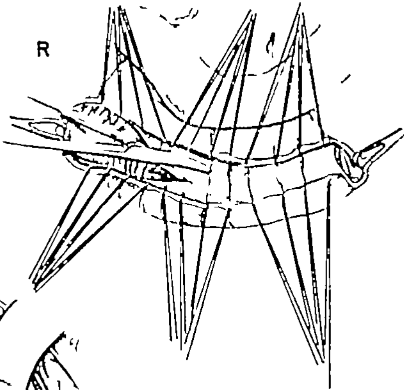
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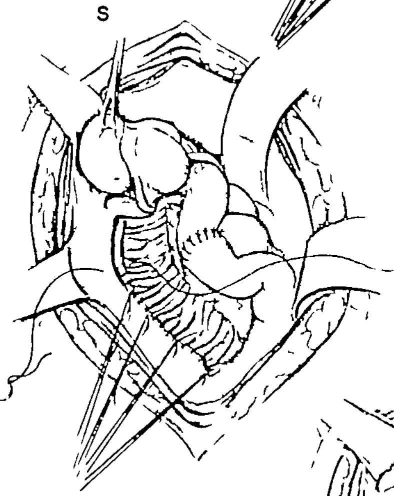
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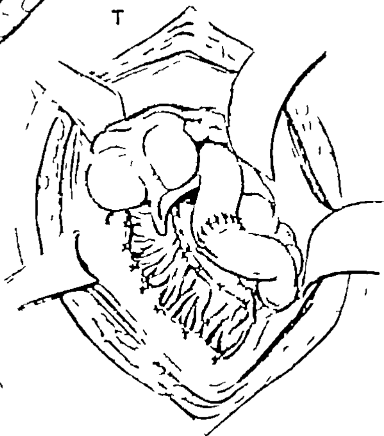
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Plate 133







A. The right paramedian midabdominal incision employed is depicted by the solid line.

B. The peritoneal cavity is more widely exposed than usually obtains at operation to show the location of the distal portion of the tumefaction in the region of the midtransverse colon.

C. A sagittal section of the region of the intussusception is shown to depict the anatomic pathologic characteristics.

D. Manual reduction of the intussusception is initiated by a gentle retrograde "milking" maneuver.

E. *The reduction of the intussusception is* completed to the region of the cecoascending colon. It is in this area that further reduction may be most difficult and at times impossible. One cannot emphasize too frequently the importance of gentleness and the avoidance of trauma during the reduction of the intussusception. The exertion of a traction force on the ileum proximally though often tempting, should not be done. In the event that the intussusception is either irreducible and/or gangrenous, ileocolic segmental resection and primary ileocolostomy is preferred to a multistage exteriorization operation.

F. The reduction of the intussusception is completed. The invaginated area on the anterior wall of the terminal ileum, frequently observed, is visible and denotes the "head" of the intussusceptum. A layer closure of the wound is subsequently performed using a continuous interlocking double strand suture of 00 catgut for the peritoneum and interrupted 000 silk sutures for the fascia and skin.

A six months old colored female infant was admitted to the hospital with the history that, 24 hours previously the passage per rectum of blood-stained mucus occurred, subsequent to which there was no bowel movement. There was no nausea or vomiting, and at no time did the patient cry out in apparent pain.

On examination the infant was quiet, well nourished, and well hydrated. The abdomen was slightly distended but there was no evident tenderness or palpable masses. On digital rectal examination, no abnormalities were observed. On auscultation of the abdomen, intermittent high pitched metallic "tinkles" were heard, consistent with an obstruction of the small bowel. A "scout" film of the abdomen showed gaseous obstruction of the small intestines.

Operation was performed within six hours after admission, both the operative findings and the method of surgical management are shown in the illustrations. Postoperative convalescence was without incident.

DISCUSSION—DR. THOMAS V SANTULLI. The typical lesion of intussusception in this age group is well illustrated with the head of the intussusception in the right side of the transverse colon. Some of the cases present a mass which lies in the transverse direction, as part of the ascending colon rises out of the right lower quadrant.

In spite of the long incision that is usually made, the surgeon will need to reduce the most distal portion of the intussusception with one hand since it is not possible to deliver the mass at this point. By gentle retrograde "milking" starting at the head of the mass, the intussusception can usually be reduced until it reaches the cecum when the mass can be delivered out of the wound. Here, the reduction can be completed by using both hands and continuing the gentle retrograde "milking" maneuver as shown in E. As emphasized, this is the most difficult part of the procedure and requires careful and gentle manipulation. The dimple which is the head of the intussusception is well shown in F.

In those cases in which the intussusception is irreducible, or if there is gangrenous bowel, ileocolic resection is mandatory. If the patient's condition is poor and he is not able to tolerate a primary anastomosis, exteriorization of the mass with subsequent anastomosis may be lifesaving.

We do not hesitate to remove the appendix in those cases where the reduction has been easily accomplished and where there is no undue edema of the cecum. Actually many of the cases of intussusception in this age group have numerous congenital peritoneal bands between the ileum and cecum involving a portion of the mesoappendix. The division of these bands and complete freeing of the ileocecal area is often best accomplished by dividing the mesoappendix and performing an appendectomy. Appendectomy should not be done if there is reason to think that appreciable risk will be added in any individual case.

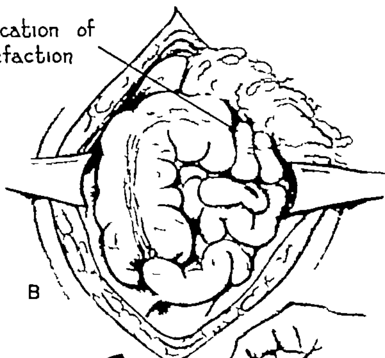
The history is not typical of the usual case of intussusception in the age group presented. Characteristically there is severe abdominal pain which is periodic. Vomiting may follow and there is the passage of blood by rectum. Physical examination will disclose the presence of a mass in the right side of the abdomen. The triad of abdominal pain, the passage of blood by rectum, and the palpation of an abdominal mass is characteristic. A barium enema will confirm the diagnosis.

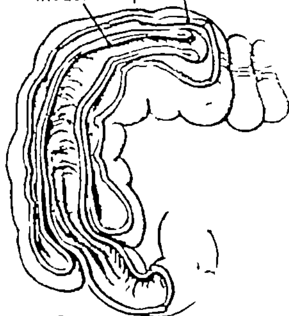
We use the barium enema to reduce the intussusception in selected cases. These are cases in which the illness is under 24 hours *and* in which there is no clinical evidence of peritoneal irritation suggesting the presence of compromised bowel (fever, elevated pulse rate, abdominal tenderness and rigidity, leukocytosis). With definite precautions and under fluoroscopic control, about 75 per cent of our cases of intussusception in recent years have been successfully reduced by hydrostatic pressure with the barium enema.

Operation is immediately undertaken if the reduction is unsuccessful. It is indicated for those patients in whom there is a high suspicion of a specific lesion causing the intussusception, and it is the treatment of choice if there is any question of compromised bowel.

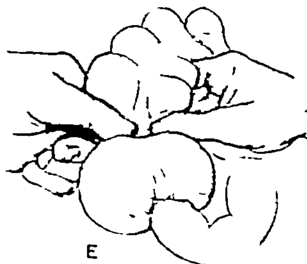
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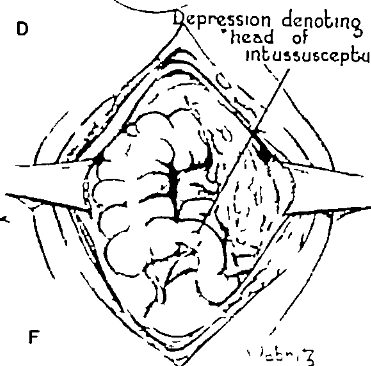

A


Distal location of
Tumefaction
B


Intussuscipiens
Intussusceptum
C


D


E


Depression denoting
head of
intussusceptum
F

RESECTION OF MECKEL'S DIVERTICULUM

Meckel's diverticulum is an embryonic remnant of the vitelline duct and indicates the site of the communication in the embryo between the yolk sac and the midgut. Characteristically it is located in the segment of the ileum one to three feet from the ileocecal junction. It is classified as a true diverticulum because (1) it contains all of the coats of the bowel wall (2) it is located on the antimesenteric surface of the bowel (3) it has a mesentery and blood supply of its own (mesenteriolum). However not infrequently the mesenteriolum is absent. Furthermore, the mucosa of the diverticulum may be either partially or completely replaced by ectopic gastric, duodenal, pancreatic, or colonic tissue.

A B C. If a mesenteriolum is present (A), it is doubly clamped (B) severed, and the ends ligated (C) to mobilize the diverticulum.

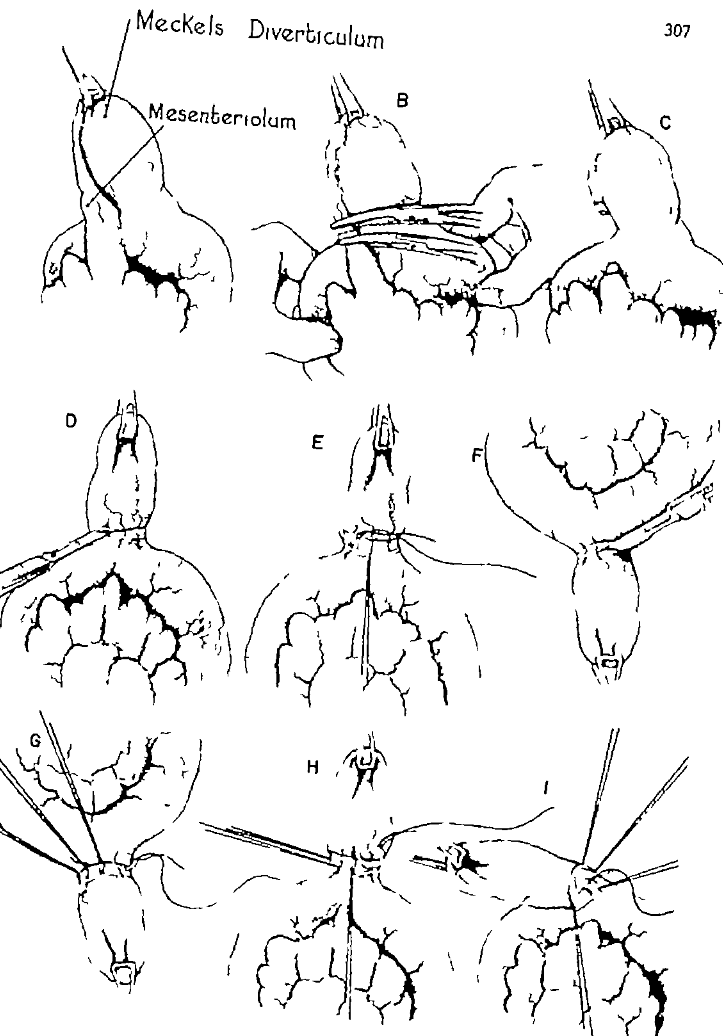
D Traction with a Babcock intestinal clamp is maintained upward on the diverticulum, and the circular incision about its base is begun.

E, F G H, I. The incision, deepened through the seromuscular layer is completed about the whole of the circumference of the base of the diverticulum. The vessels in the submucosa are undersewn and ligated with suture ligatures of fine (0000) silk.

DISCUSSION—DR PAUL C KIERNAN Meckel's diverticula are variable in size, and may contain ectopic gastric, duodenal, pancreatic or colonic tissue in either the tip or the base of the diverticulum and in the ileum adjacent to the base. Accordingly the exact technical procedure to employ for the resection of a Meckel's diverticulum may vary. In general, several important points are to be remembered and practiced (1) division and ligation of the mesentery and its contained blood supply (2) complete excision of the base of the diverticulum, (3) closure of the opening in the ileum in a line at right angles to its long axis to avoid encroachment upon the lumen.

It is not necessary to remove all Meckel's diverticula which are found during the performance of an exploratory laparotomy. The resection of a small diverticulum with a wide base in an older individual who has had no evidence of intestinal bleeding would seem to add an unnecessary risk to the procedure for which the exploration is primarily undertaken. In the young individual, although no symptoms seem to be caused by its presence and even if small, the diverticulum should be removed. Small diverticula may be the initiating cause of an intussusception. Furthermore whenever the diverticulum is in continuity with the anterior abdominal wall, either with or without a fistula, in all instances of intestinal bleeding of undetermined origin, and when a Meckel's diverticulum coexists with a duodenal ulcer or any other lesion which may be the source of bleeding, the diverticulum should be excised.

Dr Madden's technic for the resection of a Meckel's diverticulum certainly is excellently portrayed. However in my opinion, it is unnecessary to make a circular incision through the seromuscular layer about the base of the diverticulum as indicated in Plate 135 D. Furthermore, I believe it is unnecessary to undersew and ligate the vessels of the wall of the bowel separately as shown in G H, and I Plate 135. My preference is to apply a thin bladed crushing clamp to the base of the Meckel's diverticulum, excise the diverticulum, and with a suitable suture invert the crushed segment into the lumen of the ileum, taking care to apply the clamp as emphasized previously at right angles to the long axis of the ileum.


Meckels Diverticulum
Mesenteriolum
B
C
D
E
F
G
H
I

J K, L *The ligation in continuity of the vessels in the submucosa is completed (J).* The lumen of the proximal segment of the ileum is occluded with a rubber covered intestinal clamp and a crushing (Kocher) clamp is applied across the base of the diverticulum (J). An opening is made into the lumen of the bowel with a No 15 scalpel blade (J) and the resection of the diverticulum is continued by scissor dissection (K, L)

M. The amputation of the diverticulum is completed, and the hemostatic suture ligatures on either side of the opening in the bowel are cut.

N The polar ligatures are used for traction to convert the circular opening to a longitudinal one transverse to the long axis of the bowel (ileum)

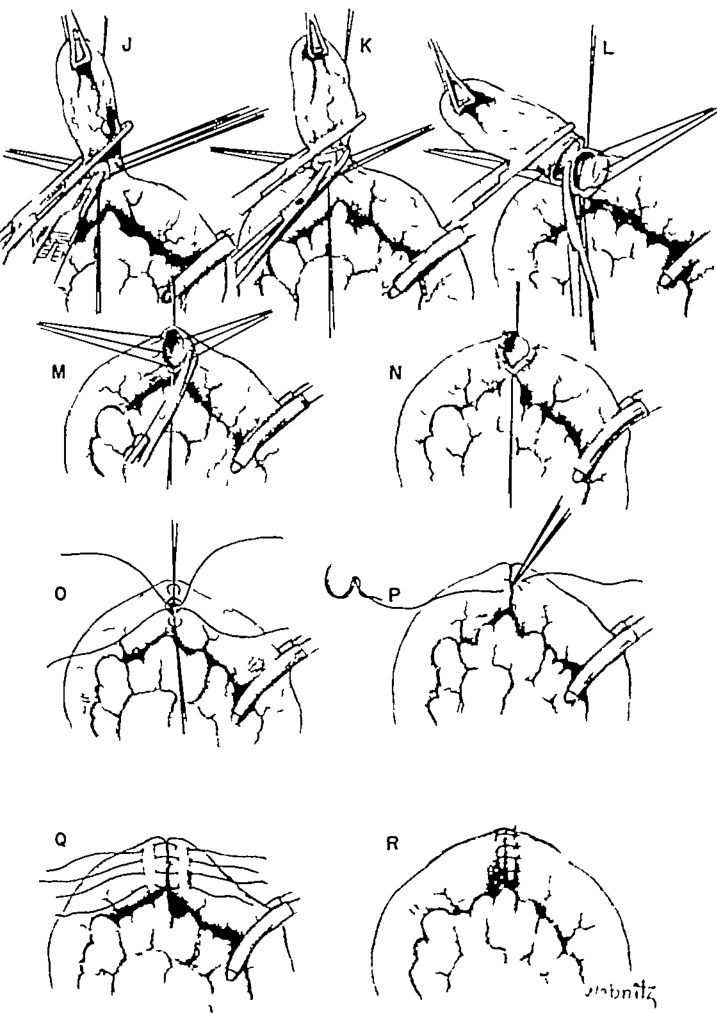
O *An enterorrhaphy is performed,* using interrupted sutures of fine (0000) silk which are inserted from the "inside out" to the "out side in" so that, when tied, the knots are on the inside of the lumen.

P A figure of 8 suture of 0000 silk is inserted about the terminal midline suture of the first layer to assure both an air tight and a water tight closure

Q R. A second reinforcing layer of interrupted seromuscular sutures (Lembert) of fine (0000) silk is inserted (Q) and tied (R) to complete the closure of the opening in the lumen of the bowel. The line of closure, at right angles to the long axis of the bowel, avoids encroachment upon and resulting constriction of the lumen.

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APPENDECTOMY

In the performance of an appendectomy any one of a variety of incisions, depending upon the preference of the surgeon, may be used. In general either a right lower paramedian muscle-retracting (lateral) or muscle-splitting incision is preferred

A. The tip of the mesoappendix is grasped in *a curved clamp (Kelly) and mobilized, with* the cecum and the terminal ileum, into the operative wound. The related anatomic structures are depicted.

B B_1 The appendix is mobilized by severance of the attached mesoappendix An opening may be made through an avascular portion *of the base of the mesoappendix through* which a ligature of silk (00) is withdrawn (B) The ligature, when tied, occludes the *appendicular artery and the site of sever* ance of the mesoappendix distally is indicated by the dotted line The objections *to this method are the inclusion of an excess* amount of fatty areolar tissue in the hemostatic ligature and the potential "slipping" of the ligature with secondary hemorrhage.

The preferred method for mobilization of *the appendix is to serially clamp and sever* the mesoappendix, the beginning of which is indicated in B

C, D The severance of the mesoappendix is completed as indicated.

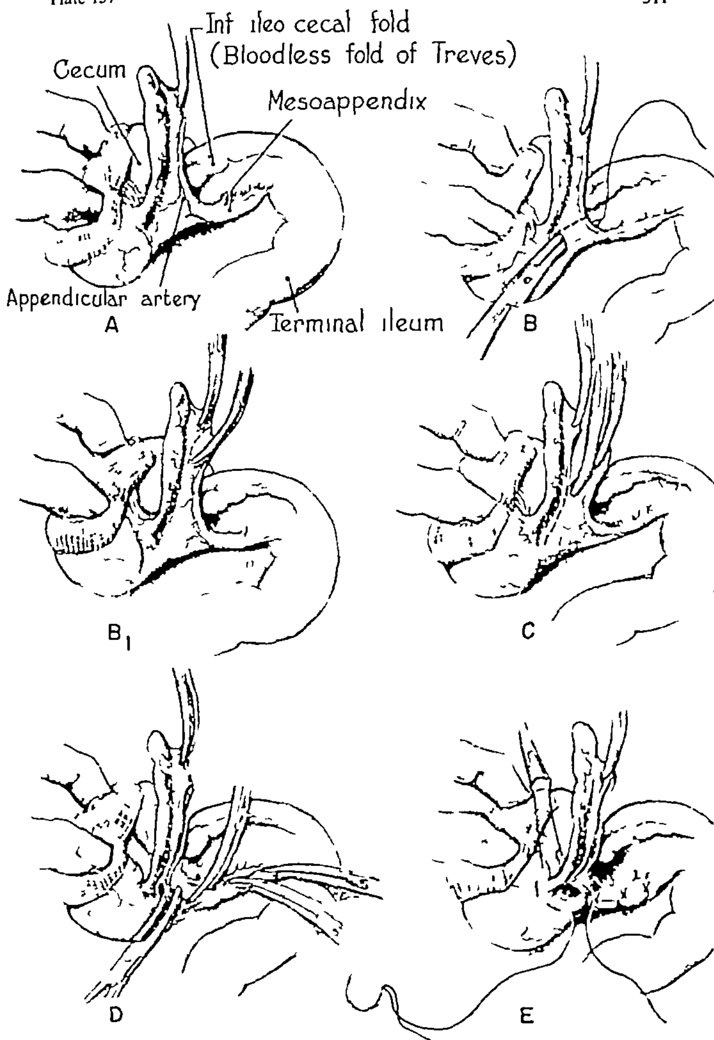
E. The mobilization of the appendix is com*pleted and the clamps on the proximal cut* margin of the mesoappendix are replaced with suture ligatures of silk (000). A *purse-string suture of silk (00) is inserted in the* wall of the cecum about the base of the appendix, and one loop of the pursestring is held in a Babcock clamp for subsequent countertraction when the stump of the appendix is inverted.

DISCUSSION—DR. PAUL C. KIERNAN. In this procedure the abdominal incision which affords the best exposure is determined by the individual surgeon. However in most instances when an appendectomy is done as a primary procedure, a low paramedian or McBurney type of muscle-splitting incision is adequate If the latter is used and additional pathology requires a more adequate exposure, a second incision *is preferred to one which enlarges the muscle* splitting type.

Identification of the appendix, usually not difficult, may be aided by tracing the taenia coli of the cecum to their point of confluence. If retrocecal, the appendix is more easily reached and removed by first dividing the lateral peritoneal attachment of the *cecum and ascending colon and mobilizing the right* colon medially

Depending upon the degree of inflammation present, either the appendix or its mesentery may be grasped Whether or not the mesoappendix is ligated and divided in toto or segmentally is dependent upon *several factors, e.g., size,* amount of contained fat, edema, or other associated inflammatory changes. If it is thin and short, the entire mesoappendix may be included in a single clamp, divided and ligated. However if marked edema and induration are present, the mesoappendix may be better clamped, severed, and ligated in segments.

In spite of all that is written relative to the treatment of the appendiceal stump either by ligation alone or inversion with or without concomitant ligation, the results seem to indicate that it makes little or no difference how the stump is treated as long as fundamental surgical practices are followed. In simple ligation of the base of the appendix, it is important that the ligature be placed proximal to any *crushed portion of the wall of the appendix.* If the ligature is placed in the crushed groove, the tissue may necrose too rapidly and cause a "blowout" of the wall of the cecum. Medicinal treatment of the base of the appendix, whether the stump is or is not inverted, is of no practical importance. In particular


Inf ileo cecal fold
(Bloodless fold of Treves)
Cecum
Mesoappendix
Appendicular artery
A
Terminal ileum
B
B1
C
D
E

F G The base and proximal portion of the appendix is "milked" distally prior to locking the clamp (F) and a ligature of silk is placed around the base of the appendix (G). The placement of this ligature in a groove formed by crushing the appendix with a clamp is neither practiced nor recommended because it leaves an area of devitalized tissue proximal to the site of the ligature.

H. The ligature (00 silk) is tied and anatomic forceps (without "teeth") are used to hold the base of the appendix at the site of its ligation.

I. A square piece of gauze split halfway and moistened in sterile saline is placed about the appendix overlying the anatomic forceps but beneath the occluded clamp The base of the appendix is then severed with a scalpel just beneath the clamp

J The severed and ligated proximal stump of the appendix is wiped with a piece of moistened gauze prior to its inversion. The scalpel used to sever the appendix is not dipped in phenol prior to use nor is the stump "treated" with cotton applicators moistened with phenol and alcohol. This ritual, although a common practice, is not recommended

K. The stump of the appendix is inverted with the aid of countertraction on the loop of the pursestring suture held in the Babcock clamp, and direct inversion with the anatomic forceps is obtained as the pursestring suture is drawn taut.

L. The inversion pursestring suture is tied, and a second reinforcing figure N or Z suture (000 silk) is inserted. The old axiom "*If you invert the appendiceal stump don t ligate and if you ligate the stump don t invert,*" is not followed. The objection to ligation and inversion namely that you invert an infected stump into a closed peritoneal space and thereby predispose to the occurrence of a complicating abscess in the cecal wall, is not believed of practical importance This complication, though admittedly a possibility has not been observed by the author

The indication for drainage following appendectomy is not "When in doubt, drain." In the presence of a complicating abscess, drainage is always practiced. In the absence of an abscess the indication for drainage following the removal of an acutely suppurative or gangrenous appendix is dependent upon the appearance of the adjacent peritoneum If the peritoneum is glistening and healthy in appearance, drains are not used. However if the peritoneum is edematous, studded with petechiae, and lacking its normal luster drainage is performed because these findings are believed to indicate that the protective mechanism of the peritoneum is compromised and drainage is needed. The drain should not be removed before the seventh postoperative day Furthermore, whether a drain is or is not used, if "diarrhea" should occur between the fifth and eighth days postoperatively the first thing a surgeon should do is a digital rectal examination to rule out the presence of a pelvic abscess. All too frequently medication to control the irritative pseudodiarrhea is empirically prescribed and continued for varying periods of time before the correct diagnosis is made.

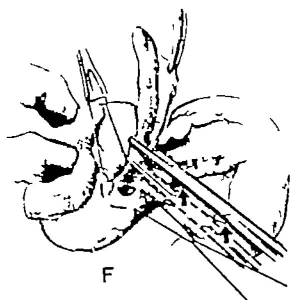
DISCUSSION—DR. KIERNAN (cont.)

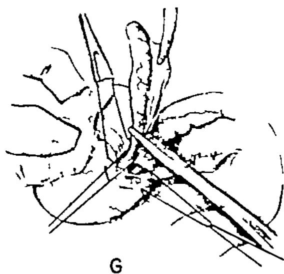
carbolic acid or other caustic solutions should not be used However the use of a cautery to sever the base of the appendix is practiced with success by many surgeons The contamination of the peritoneum which may result from an infected base of the appendix is well tolerated so long as the source of the contamination is controlled, *i e* adequate ligation or inversion of the stump of the appendix

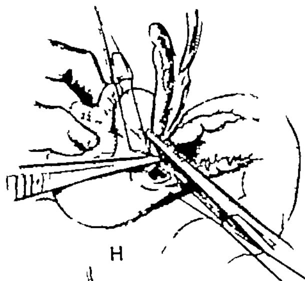
In the absence of a localized abscess, drainage of the peritoneal cavity is rarely needed However when there is gross contamination of the wound, the avoidance of necrosis of the abdominal wall and resultant hernia may be assured by closure of only the peritoneum and by the insertion of sutures which are untied through the skin, subcutaneous fat, and fascia layers The open wound is loosely packed with sterile gauze, which is removed in 24 to 36 hours, and the wound closed secondarily with the previously inserted but untied sutures.

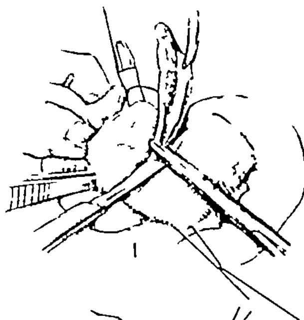
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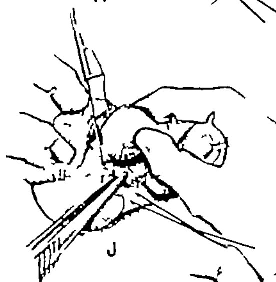
Plate 138

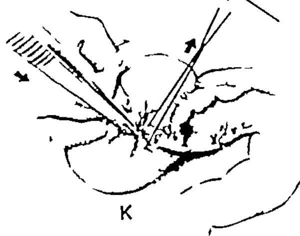


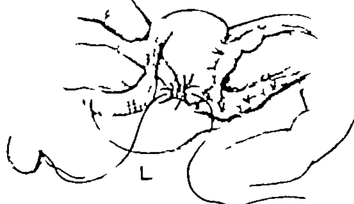












F, G The base and proximal portion of the appendix is "milked" distally prior to locking the clamp (F), and a ligature of silk is placed around the base of the appendix (G). The placement of this ligature in a groove formed by crushing the appendix with a clamp is neither practiced nor recommended because it leaves an area of devitalized tissue proximal to the site of the ligature.

H. The ligature (00 silk) is tied and anatomic forceps (without "teeth") are used to hold the base of the appendix at the site of its ligation.

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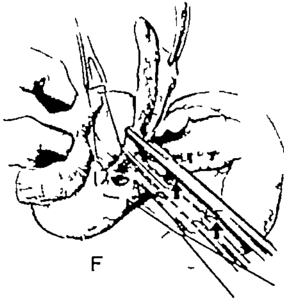
L. The *inversion pursestring suture is tied*, and a second reinforcing figure N or Z suture (000 silk) is inserted. The old axiom "If you invert the appendiceal stump, don't ligate, and if you ligate the stump don't invert," is not followed The objection to ligation and inversion, namely that you invert an infected stump into a closed peritoneal space and thereby predispose to the occurrence of a complicating abscess in the cecal wall, is not believed of practical importance This complication, though admittedly a possibility has not been observed by the author

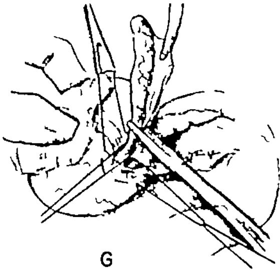
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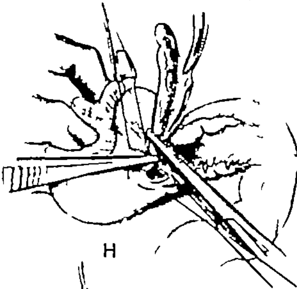
Discussion—Dr Kiernan (cont.)
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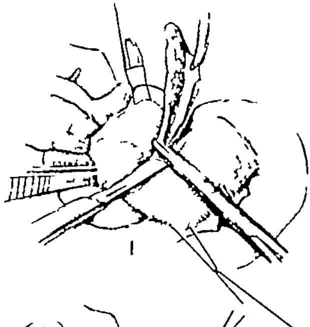
In the absence of a localized abscess, drainage of *the peritoneal cavity is rarely needed. However,* when there is gross contamination of the wound, the avoidance of necrosis of the abdominal wall and resultant hernia may be assured by closure of only the peritoneum and by the insertion of sutures which are untied through the skin, subcutaneous fat, and fascia layers The open wound is *loosely packed with sterile* gauze, which is removed in 24 to 36 hours, and the wound closed secondarily with the previously inserted but untied sutures.

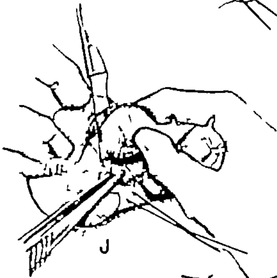
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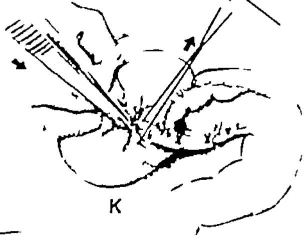

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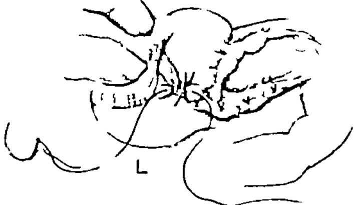

G


H


I


J


K


L

ILEOSTOMY AND SUBTOTAL COLECTOMY

A. The sites of the ileostomy stoma in the right lower quadrant and the left paramedian muscle splitting incision are depicted in dotted outline.

B. The peritoneal cavity is entered, and the wound margins are retracted to expose the subjacent viscera.

C. Manual traction is maintained upward on the omentum and downward on the transverse colon as the relatively avascular attachments of the omentum to the colon are separated by scalpel dissection.

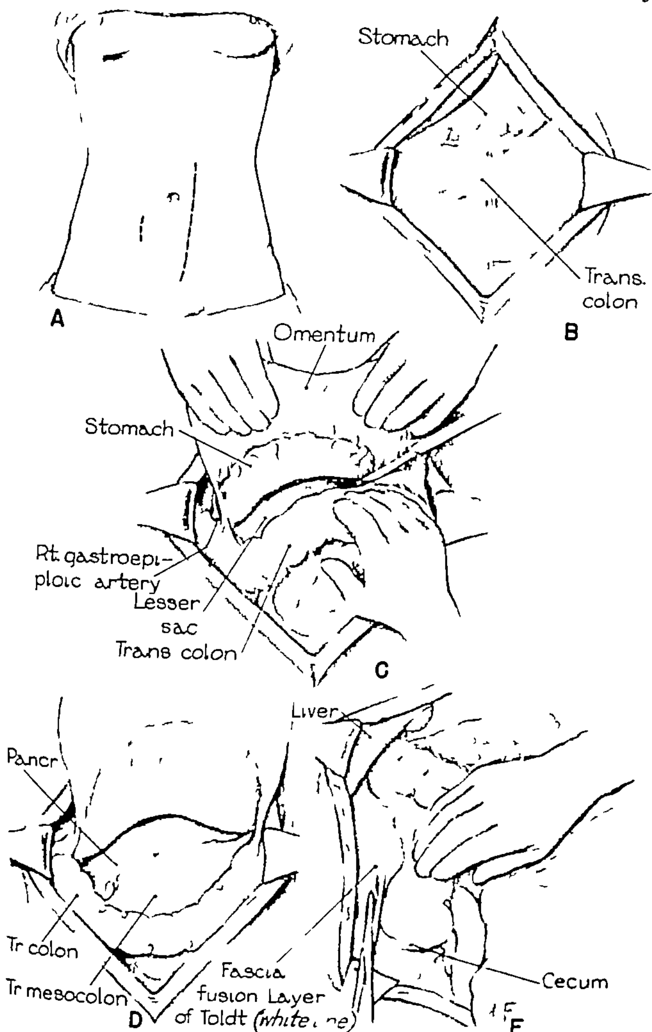
D. Upon completion of the detachment of the omentum, the transverse colon is mobilized and the lesser peritoneal sac is entered.

E. The ascending colon is manually retracted *toward the midline, and the mobilization of* the right side of the colon is commenced by scissor dissection along the "white line," the fascia fusion layer of Toldt

DISCUSSION—DR. CLARENCE DENNIS In reference to Plate 139 A, if the ileostomy is made precisely in the belt line and in the midportion of the belly of the right rectus muscle, the intact skin around it provides a smooth and slightly convex flexible surface for the later adhesion of an ileostomy bag. It is wise to note the position of the transverse creases which form across the abdomen when the patient bends over These creases should be avoided in placing the ileostomy for they make secure cementing of an ileostomy bag impossible

In a considerable number of my first twenty-odd colectomies, careful preservation of the omentum (Plate 139 C) was followed by distressing evidence of adhesive obstruction. Since that time the omentum has been completely removed routinely with the specimen, and gratifying freedom from such complications has been observed. *This experience covers a total of more than 100 colectomies.*

It is usually preferable to commence the intraabdominal dissection by freeing the cecum and ascending colon (Plate 139 E) together with the very terminal


A
Stomach
Trans. colon
B
Omentum
Stomach
Rt. gastroepiploic artery
Lesser sac
Trans colon
C
Liver
Pancr
Tr colon
Tr mesocolon
D
Fascia fusion Layer of Toldt (white line)
Cecum
E

F G The hepatic flexure of the colon is mobilized by severance of the right phrenocolic ligament (dotted outline), and the retrocolic portion of the duodenum is exposed (G).

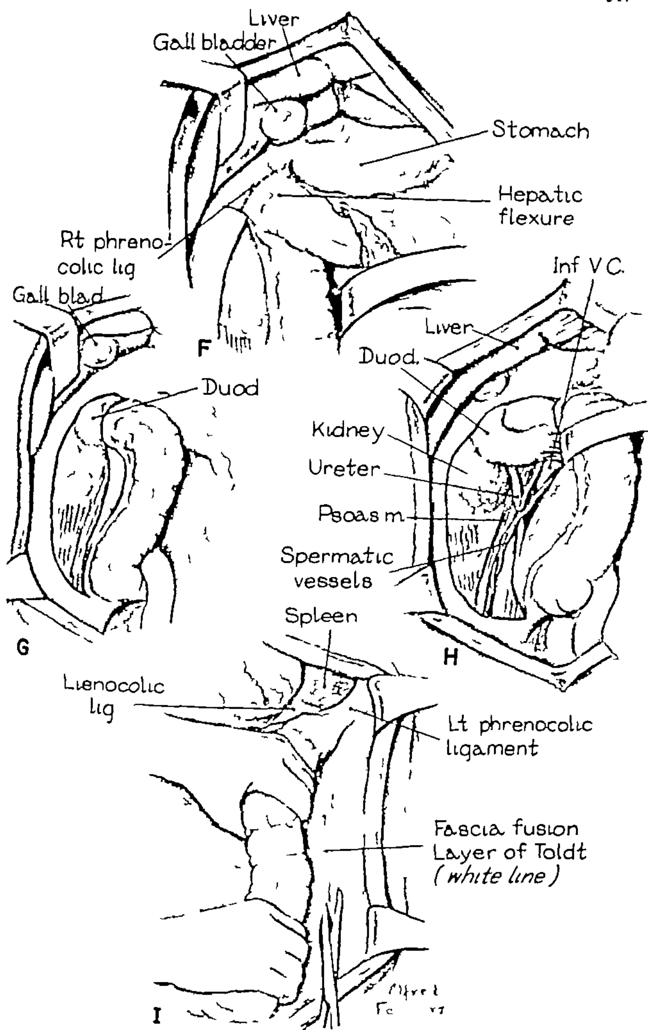
H. The right side of the colon, completely mobilized, is rotated toward the midline, and the related structures in the retroperitoneal area are visible. In this mobilization one must be careful to avoid injury to the spermatic or ovarian vessels, the right ureter the inferior vena cava, and the retrocolic portion of the duodenum.

I. The descending colon is manually retracted toward the midline, and its mobilization, similar to that on the right side, is commenced by scissor dissection along the fascia fusion layer of Toldt ("white line").

Discussion—Dr Dennis (cont.)

ileum. This is done because it is not possible to determine the exact level of invasion of the inflammatory process into the terminal ileum by gross examination of either the serosal or the mucosal surfaces. Since it is of paramount importance that the ileostomy be fashioned from the lowest normal segment of ileum, it is worthwhile to remove a short segment of the lowest area of the terminal ileum which appears normal and have rapid frozen sections prepared. The further dissection in the abdomen can be pursued while the pathologist is examining the specimen. Cellular infiltration of the submucosa or muscularis is an indication that the segment under consideration is involved with the process and that it would be wise to resect a few centimeters more of the terminal ileum. The precise level at which the ileostomy is to be made is of extreme importance in the subsequent maintenance of satisfactory water balance because the lowest portion of the terminal ileum is extremely important in water reabsorption Furthermore, the utilization of inflamed intestine to make an ileostomy is productive of a high incidence of late ileostomy complications. It is, therefore, essential to control the level of division by the study of rapid frozen section preparations of excised portions of the terminal ileum.

A smoother surface of skin about the ileostomy can be achieved if one utilizes a circular incision rather than the simple longitudinal one illustrated (Plate 142, P). The circular incision is very satisfactory if made essentially as one would make it with a cork borer The hemostasis must be meticulous, and the burial of suture material in the substance of the abdominal wall at this point should be minimized Very fine catgut, or better the utilization of the coagulation current in extremely careful fashion is worth while. It is my preference to preserve as much of the mesentery of the resected terminal ileum as possible, and to have the mesenteric margin of the terminal ileum directed laterally rather than cephalad as shown (Plate 142, R). The purpose of saving this mesentery is to simplify the construction of a complete diaphragm bounded by the anterior lateral, and posterior abdominal walls and the segment of ileum


Liver
Gall bladder
Stomach
Hepatic flexure
Rt phreno-colic lig
F
Gall blad
Duod
G
Inf V.C.
Liver
Duod.
Kidney
Ureter
Psoas m.
Spermatic vessels
H
Spleen
Lienocolic lig
Lt phrenocolic ligament
Fascia fusion Layer of Toldt
(white line)
I

J The mobilized descending colon is displaced medially and the left phrenocolic ligament is severed. The mobilization of the left side of the colon is completed after severance of the lienocolic ligament as indicated in dotted outline

K. The vascular pattern of the right side of the colon is demonstrated, and the levels for division of the terminal ileum and the sigmoid colon are indicated by encircling traction tapes of rubber tissue.

L. An incision is made through the serosal covering of the mesentery of the terminal ileum as a guide tract for the serial clamping and division of the mesentery

M. The division of the mesentery of the terminal ileum is completed, and clamps are applied to the ileocolic and middle colic branches of the superior mesenteric artery prior to their severance.

N. The severance of the mesenteric vascular attachment to the colon is completed to the left colic artery the first branch of the inferior mesenteric artery The guide tract for the division of the mesentery of the sigmoid colon and its contained left colic artery is depicted.

O The sigmoid colon is doubly clamped at the junction of its middle and lower thirds and divided as indicated in dotted outline. The handle of the distal clamp is directed toward the center of the abdomen to facilitate its support when the wound dressing is applied.

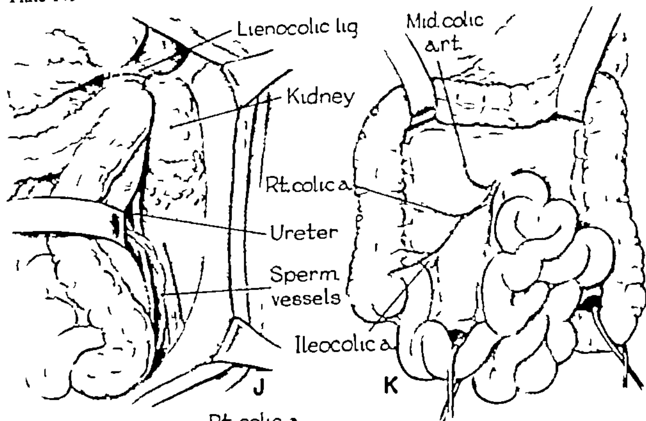
DISCUSSION—DR. DENNIS (cont.)

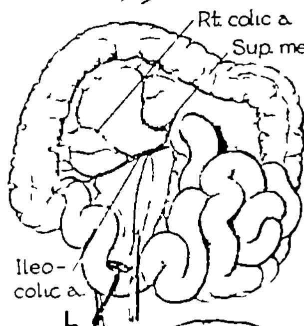
forming the ileostomy Only by meticulous closure of the defect lateral to the ileostomy may one be assured that whole segments of the intestinal tract will not wrap around the segment of ileum and cause a strangulating intestinal obstruction. In my experience this happened six times prior to the construction of a hemidiaphragm as described

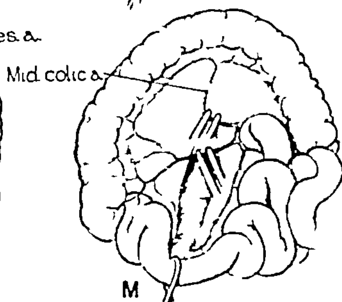
The incidence of late hernia formation, stenosis, or prolapse of the ileostomy can be markedly reduced by the very careful suture of the ileum to the posterior rectus sheath and peritoneum as it passes through the abdominal wall For this purpose my preference is to use about 15 silk sutures (0000). The proper placement of these sutures is most important. The bite upon the peritoneal surface of the ileum must be precisely parallel to the one in the posterior rectus sheath and peritoneum The suture must not penetrate into the mucosa and it must not be tied tightly enough to cause strangulation Although I have seen three instances in which fistulas formed about such sutures placed at the time of ileostomy I personally have had none in the [illegible] of over 125 ileostomies with the plac[illegible] described. Furthermore, in this s[illegible] did not occur in any patient in whom t[illegible] mal at the level at which the ileostomy was performed

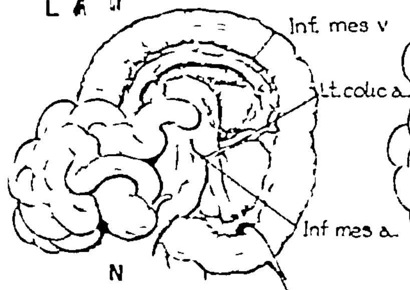
In the early cases in the series performed at the University of Minnesota, the parietal reperitonization was performed similarly to that indicated (Plate 142, S), but the incidence of complications was high. In the last more than 100 cases, this reperitonization has not been done in either the right or the left gutter and no drains have been used. There has been no recognized complication from pursuit of this course.

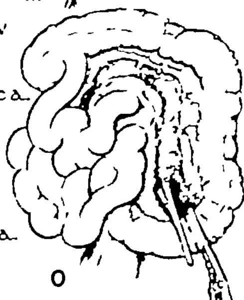
In patients who are critically ill, it is appropriate to bring out the distal segment of colon through the bottom end of the abdominal incision (Plate 142, T). Frequency of retrograde purulent drainage onto the abdominal wall and secondary pyoderma are symptoms distressing enough to lead to the decision to remove the rectum at the time of total colectomy In those patients who are not too ill to have the two opera[illegible] in one stage. It is my personal prefe[illegible] re the technic of B N Brooke of Birmi[illegible] nd (Plate 143 F) of everting the ileum [illegible] as not to leave any uncovered sero[illegible] nage from the terminal ileum In tho[illegible] the level of the ileostomy has been [illegible] ed by rapid [illegible] ion


Lienocolic lig
Kidney
Rt. colic a.
Ureter
Sperm. vessels
J
Mid. colic art.
Ileocolic a.
K


Rt. colic a.
Sup. mes. a.
Ileo-colic a.
L


Mid. colic a.
M


Inf. mes. v
Lt. colic a.
Inf. mes. a.
N


O

P, Q Through a small incision to the right of and below the umbilicus, a clamp is applied to the proximal portion of the distal segment of the ileum A second clamp is applied through the laparotomy incision to the ileum immediately distal to the first, and the ileum is severed between the clamps.

R. The distal cut end of the ileum is covered with a rubber diaphragm, and the proximal cut end is brought out through the small incision to the right of and below the umbilicus. To lessen the tendency for mucosal prolapse of the ileum, the cut margin of the ileal mesentery is sutured to the anterior parietal peritoneum.

S. The operative field, following completion of the operation, is shown. A partial reperitonization is performed, and a drain is inserted into the retroperitoneal area. Prior to closure of the incision the omentum is replaced over the small intestines

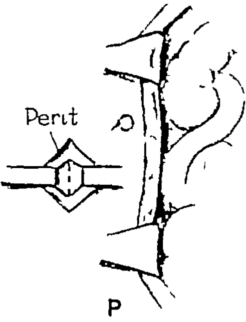
T The wound closure is completed about the retroperitoneal drain and the terminal portion of the sigmoid colon. To minimize the incidence of fistula formation, no sutures are used to anchor the ileum to any portion of the abdominal wall. A tube is secured in the lumen of the ileum to permit escape of the ileal contents into a bedside receptacle. The tube is ejected spontaneously between the fifth and seventh days when the retaining necrosing ligature sloughs through.

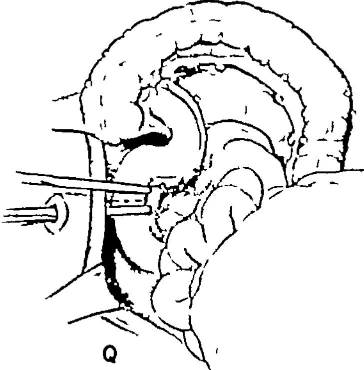
DISCUSSION—DR. DENNIS (cont)

studies and this technic employed, the passage of formed stools within the first four or five days is usually observed.

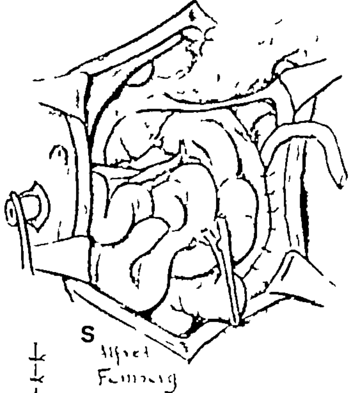
In the re-explorations of patients following ileostomy and either subtotal or total colectomy I have been deeply impressed with the paucity of complications in those cases in which, at the primary operation, gentleness in the handling of tissues, meticulous hemostasis, the use of the finest and the least possible amount of suture material, and rigid adherence to strict aseptic surgical technic were practiced If, in the performance of a colectomy the utmost care is utilized to prevent drying, excoriation, or other trauma to the ileum, exploration at a later date reveals routinely the complete absence of any adhesions whatsoever in the abdominal cavity The utilization, therefore, of the Noble plication technic (Plate 143 E) appears to me unnecessary Leland S McKittrick has emphasized that the development of enteritis above ileostomies that are properly prepared is almost never observed unless there is some obstruction at the ileostomy In the re-explorations previously mentioned, the ileostomies which were considered truly satisfactory were only those in which the ileum just proximal to its passage through the abdominal wall was neither hypertrophied nor dilated.

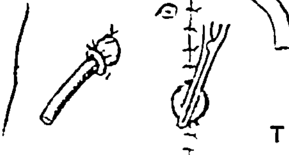
The variance of these comments from the technic illustrated is an indication of the frequency with which a desired result may be obtained by a variety of successful maneuvers


Perit
P


Q


R


S


T

This plate illustrates the combination of four procedures suggested by Garlock to prevent ileal dysfunction. During the past two years, all or several of the methods illustrated have been used with excellent results. Accordingly this is now the preferred technic in the establishment of the ileostomy stoma.

A, B, C. An opening is made into the peritoneal cavity after the removal of a wafer of skin as advocated by Dennis to avoid scar contracture of the skin at the site of the ileostomy

D. The attachment of the cut margin of the mesentery of the ileum to the anterior parietal peritoneum is depicted.

E. Plication (Noble) of the terminal portion of the ileum, recommended by Lichtenstein and Herzikoff for the prevention of ileal prolapse.

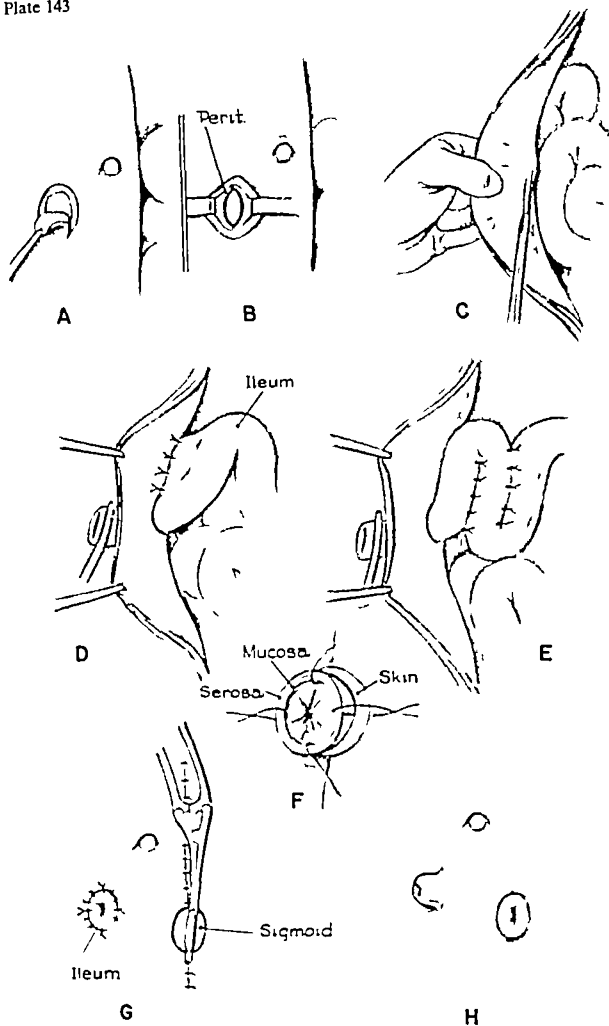
F G. The immediate suturing of the whole thickness of the wall of the ileostomy stoma to the skin margin. Prior to suturing, the terminal ileum projects approximately 4 cm. from the skin surface Four cardinal sutures of silk (000) are first inserted (F) and held taut but not tied. In between these sutures a series of interrupted silk sutures are inserted to complete the eversion of the ileal stoma (G) This procedure, suggested by Brooke, is used routinely to prevent stenosis and dysfunction of the ileostomy which frequently occur following simple exteriorization with spontaneous eversion of the terminal ileum.

H. Appearance of the ileostomy and colostomy stomata five weeks postoperatively One may note the spoutlike projection of the terminal ileum at this stage compared to its flat appearance immediately postoperative (G)

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Plate 143



TRANSVERSE COLON COLOSTOMY

A. The transverse incision in the right upper quadrant of the abdomen is outlined and crosshatched to facilitate later closure.

B C. The wound margins are retracted, and the underlying anterior rectus sheath and the rectus muscle are incised transversely to expose the transversus abdominis muscle and the transversalis fascia.

D. The transversalis fascia is incised, and a portion of the anterior parietal peritoneum is tented preparatory to its incision.

E. The opening in the peritoneum is extended both medially and laterally by scissor dissection to expose the underlying intraperitoneal viscera.

F G. The greater omentum is mobilized by scissor dissection from its relatively avascular attachment to the transverse colon (F). The dotted line (F) depicts the site of the opening to be made in the greater omentum *through which the transverse colon is* withdrawn (G).

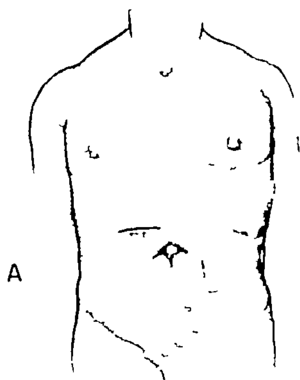
It should be emphasized that, in those instances in which the obstructed colon is *tensely dilated* a preliminary suction decompression with a 19 gauge needle should be done before attempting to mobilize the transverse colon. Otherwise, there is the danger of perforating the thin and distended bowel wall. Following the decompression, a pursestring suture is inserted in the wall of the decompressed and thickened bowel about the needle and the suture is tied as the needle is withdrawn. The pursestring suture should not be inserted prior to the needle decompression because of the increased likelihood of gross contamination of the wound through the sites of the needle punctures.

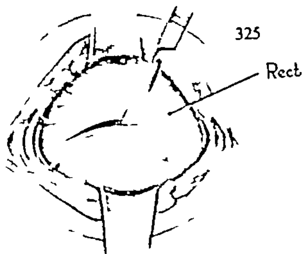
DISCUSSION—DR. J. ENGLEBERT DUNPHY. The transverse incision shown in Plate 144 A, is an excellent choice, particularly as the supporting glass rod under the colostomy lies at a right angle to the incision. There are disadvantages, however and, before selecting the transverse incision, it is well to be sure of the position of the colon. This can frequently be accurately ascertained by a review of plain films taken prior to operation.

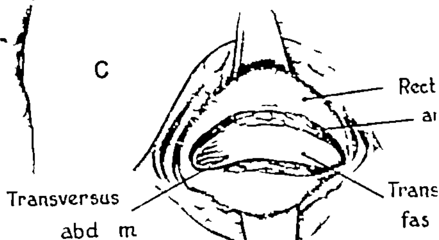
Once the peritoneal cavity is opened, it is always a difficult decision as to whether or not any exploration should be done through the transverse colostomy incision. In semielective cases where the condition of the patient is good and the degree of intestinal obstruction not extreme it is desirable to explore the abdomen, particularly the liver and gallbladder regions, since it will not be as easy to explore this area through a lower abdominal incision once the colostomy has been made.

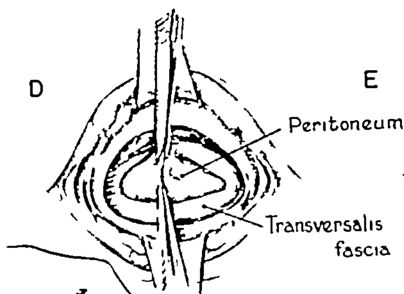
It is not always necessary to free the omentum from the colon as shown in Plate 144 F. Frequently and particularly in thin patients, the colon may be brought through the omentum in an avascular area, thus avoiding the delivery of most of the omentum into the wound. This is a particularly advantageous step if the patient is quite ill and the procedure is done under local anesthesia.

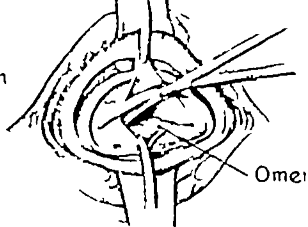
It is very important, as emphasized, not to attempt


A

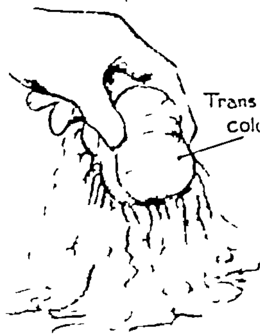

B
Rect


C
Rect
ar
Transversus
abd m
Trans
fas


D
Peritoneum
Transversalis
fascia


E
Omen


F


G
Trans
colo

H I. An opening is made through an avascular portion of the mesentery of the transverse mesocolon immediately subjacent to the bowel wall (H), and through this opening a solid glass rod is withdrawn (I).

J A rubber tube is attached to either end of the solid glass rod, and the transversalis fascia and peritoneum are sutured together as a single layer using interrupted sutures of 000 silk.

K. The closure of the transversalis fascia and peritoneal layer on either side of the exteriorized loop of proximal transverse colon is completed, and the suturing of the anterior rectus sheath and rectus muscle is begun (000 silk)

L, M. The fascia (L) and skin (M) closures are completed, and, with the use of an actual cautery an opening is made in the midportion of the anterior wall of the exteriorized loop of transverse colon (M).

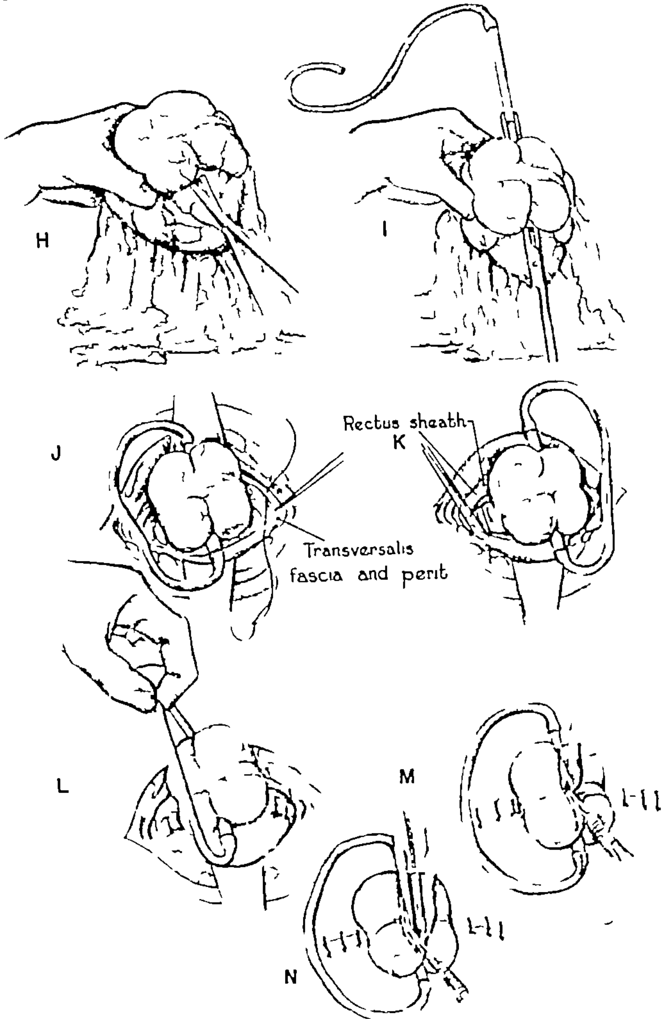
N The ends of anatomic tissue forceps (without teeth) are inserted into the lumen of the bowel to elevate the anterior wall of the colon as the incision at a right angle to its longitudinal axis is completed The use of the forceps as demonstrated lessens the incidence of burn trauma to the mucous membrane of the posterior wall of the colon and the resulting herniation of edematous tissue through the colostomy stoma.

Discussion—Dr. Dunphy (cont.)

to deliver a tensely dilated obstructed colon This brings up the question as to when cecostomy should be done rather than colostomy and, in general, where one wishes complete diversion of the fecal stream as in inflammatory lesions of the lower colon, a colostomy is by far the better choice On the other hand, in extremely ill, markedly distended, obese, or otherwise poor risk patients, a cecostomy is an easier operation for the patient to stand and can be performed with considerably less risk. Local anesthesia is far more suitable for a cecostomy than for a transverse colostomy

The simple loop transverse colostomy over a glass rod, as shown in the illustrations, is an extremely valuable procedure for defunctioning the distal colon. More elaborate methods of defunctioning the bowel such as those described by Devine or Wangensteen have little to offer over this procedure, provided it is well done. The incision in the bowel, if one wishes complete diversion of the stream, should be in the transverse direction as shown in Plate 145 M, and should be sufficiently long to allow eversion of the loop and a true double-barreled colostomy This operation has all the advantages of the more complicated procedures and yet lends itself very well, as shown later to closure.

Plate 145


H
I
J
Rectus sheath
K
Transversalis
fascia and perit
L
M
l-l l
N
l-l l

A. The longitudinal elliptical incision about the transverse colon colostomy is indicated by the dotted line. The healed lower abdominal left paramedian incision may also be seen.

B. Close up view showing the stomas of the afferent and efferent loops of transverse colon and the elliptical incision which has been deepened into the subcutaneous tissue plane.

C, D E. Kocher clamps for traction are applied to the skin margins immediately adjacent to the respective bowel stomas, and by scalpel dissection the afferent and efferent limbs of the transverse colon are mobilized into the wound. In this dissection the peritoneal, muscle, and fascial layers are clearly delineated.

F The mobilization of the colonic segment is continued until the free peritoneal cavity is entered. A loop of small intestine, adherent to both the afferent and the efferent limbs of the transverse colon, is also visible

G By digital exploration the completeness of the mobilization of the colon intraperitoneally is determined. An intraperitoneal rather than an extraperitoneal closure of the colostomy is preferred. Furthermore, with this type of closure the incidence of postoperative incisional hernia is believed lessened.

H, I J The everted mucosal cuff is mobilized by scalpel dissection (H), and upon its completion the rim of skin and attached mucosa is excised (I, J).

K. The omental collar an adherent remnant of a portion of the omentum through which the transverse colon was withdrawn in establishing the colostomy is removed by scalpel dissection.

DISCUSSION—DR. J ENGLEBERT DUNPHY The time at which a transverse colostomy should be closed is always settled by a combination of factors in particular instances However the longer a colostomy has been present, the more it tends to contract and the easier it is to close This is particularly true if the purpose for which the colostomy was made was of short duration and the glass rod removed early since there is a tendency then for this type of transverse colostomy to gradually withdraw and contract into the abdominal wall. In the obese, poor risk patient this may proceed to the point where closure becomes quite simple and can be done under local anesthesia as an extraperitoneal procedure.

Intraperitoneal closure is preferable, however particularly in younger people and those who are obliged to work, since some degree of hernia of the abdominal wall is always present in an extraperitoneal closure

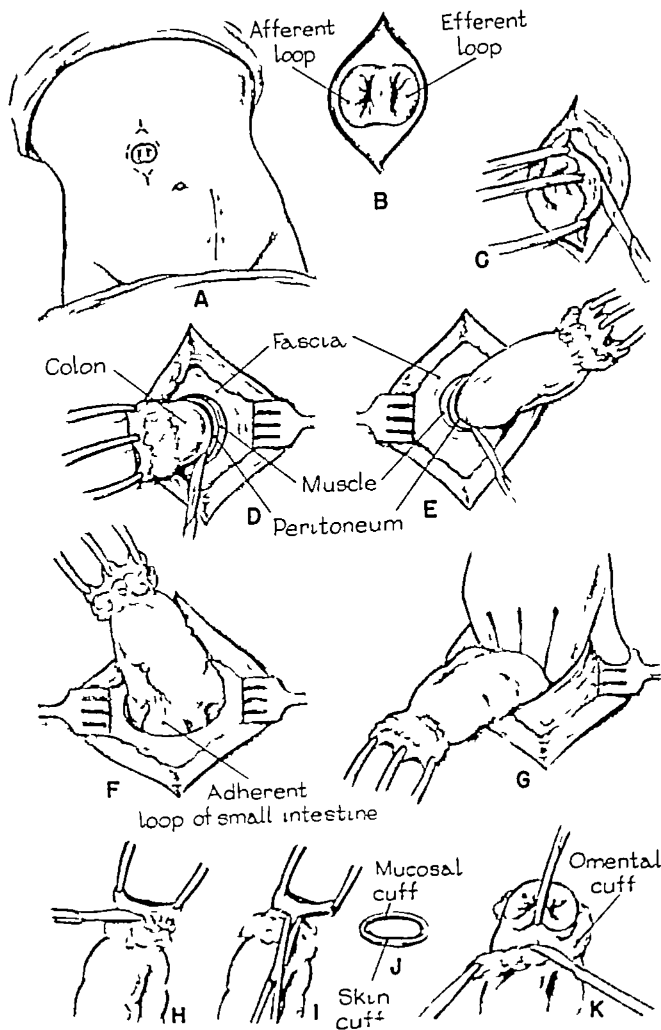
The important features of closure are well illustrated in the text The bowel wall should be identified, and here there is always a well defined dissection plane which separates the bowel and omentum from the tissues of the abdominal wall. Once this plane is recognized, it is comparatively easy to separate the bowel successively from the fascia, muscle, and peritoneum.

Effective closure of the opening into the bowel depends on very careful freeing of the cuff of skin, subcutaneous tissue, and omentum which adhere to the serosa of the bowel This cuff should not be dissected until the bowel is mobilized and ready for closure since the bowel becomes quite thin-walled and fragile after dissecting these tissues away from it. Sometimes, after careful freeing of the cuffs of tissue about the bowel, there is not enough bowel wall to permit the closure as shown in Plate 147 L and M. If, as the lateral cuffs of bowel are brought together there is tension, it may be necessary to resect the area and perform an end-to-end anastomosis. One should never hesitate to do this when the closure appears insecure and an intraperitoneal closure is contemplated

Extraperitoneal closure of a transverse colostomy is performed in much the same fashion as illustrated, except that the procedure is halted at E (Plate 146) and the bowel lumen closed. The loosely attached peritoneum often permits the bowel to be placed below the fascia and closure to be accomplished above it. This procedure has certain advantages in the very elderly and poor risk patients who may have been subjected to several difficult stage operations previously

Fortunately today it is rarely necessary to carry out transverse colostomy because patients are seen earlier and improved technics permit primary resection and anastomosis. On the other hand, the old adage that if there is any significant degree of obstruction, a colostomy is the wiser choice before resection is still a sound one. Despite certain opinions to the contrary this would seem to be particularly the case in the presence of inflammatory lesions of the distal colon

Plate 146


Afferent loop
Efferent loop
A
B
C
Colon
Fascia
Muscle
D
Peritoneum
E
F
Adherent loop of small intestine
G
H
I
Mucosal cuff
J
Skin cuff
Omental cuff
K

L. The insertion of the first anterior layer of the closure is begun The suture (00 chromic catgut) is inserted from the "inside out" on the afferent stoma and from the "outside in" on the efferent stoma so that, when tied, the knot is on the inside of the lumen.

M. A similar suture is started from the opposite angle of the anastomosis and, when tied, it proceeds from the "inside out" on the afferent stoma. It then crosses over to the opposite side and passes from the "out side in" and from the "inside out" on the efferent stoma to place the loop of the su ture on the mucosa. This inversion or Con nell type of suture is continued from either angle of the anastomosis toward the center as indicated by the arrows.

N O Each suture having reached the center of the anastomosis (N) is then inserted from the "inside out" in the apposing bowel lumen (O) and then tied together

P The second layer of the closure consists of a series of interrupted seromuscular mat tress sutures (Halsted) of 000 silk. If pre ferred, either simple interrupted sutures or a continuous seromuscular suture (Lembert) may be used.

Q R S. The ends of the Halsted mattress sutures are separated, and two pieces of at tached omentum are held in forceps (Q) preparatory to being placed over the line of the anastomosis (R) to which they are anchored when the long ends of the mat tress sutures are tied (S).

T U The peritoneal, fascial, and muscle layers on each side of the incision are approximated together as one layer using the Jones type of closure. Each suture (0 silk) is inserted through the fascia, muscle, and peritoneum on one side, and through the peritoneum, muscle and fascia on the other The suture is then crossed over to the opposite side and is inserted through the fascial layers first on one side and then on the other (T). The complete closure is depicted in U

V The skin incision is closed using inter rupted sutures of 000 silk. Prior to closure, the wound is irrigated with copious quan tities of warm saline solution. Drainage of the wound is not employed.

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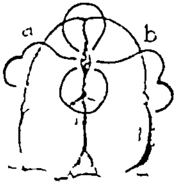
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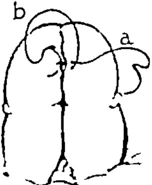
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L

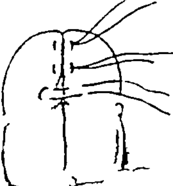

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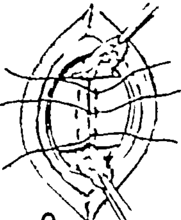


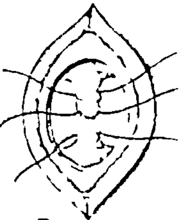
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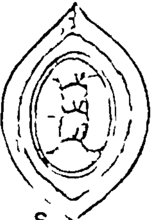


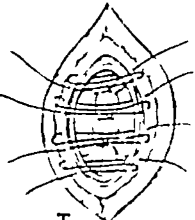
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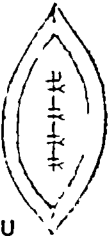

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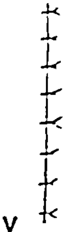

Q


R


S


T


U


V

RADICAL RIGHT HEMICOLECTOMY

A. A midabdominal right paramedian muscle retracting (lateral) incision is outlined.

B. The anterior rectus sheath is incised, the rectus muscle is retracted laterally and the line of incision in the anterior parietal peritoneum is demonstrated.

C. The opening into the peritoneal cavity is completed, and the underlying viscera are depicted.

D The omentum and small intestines are displaced mesially and the mobilization of the right side of the colon is commenced by scissor dissection along the fascia fusion layer of Toldt ("white line")

E. The mobilization of the right side of the colon is continued by digital dissection in the retroperitoneal tissue plane For purpose of clarity the tumor mass is not covered. Routinely it is encased in a thick, moist gauze pad.

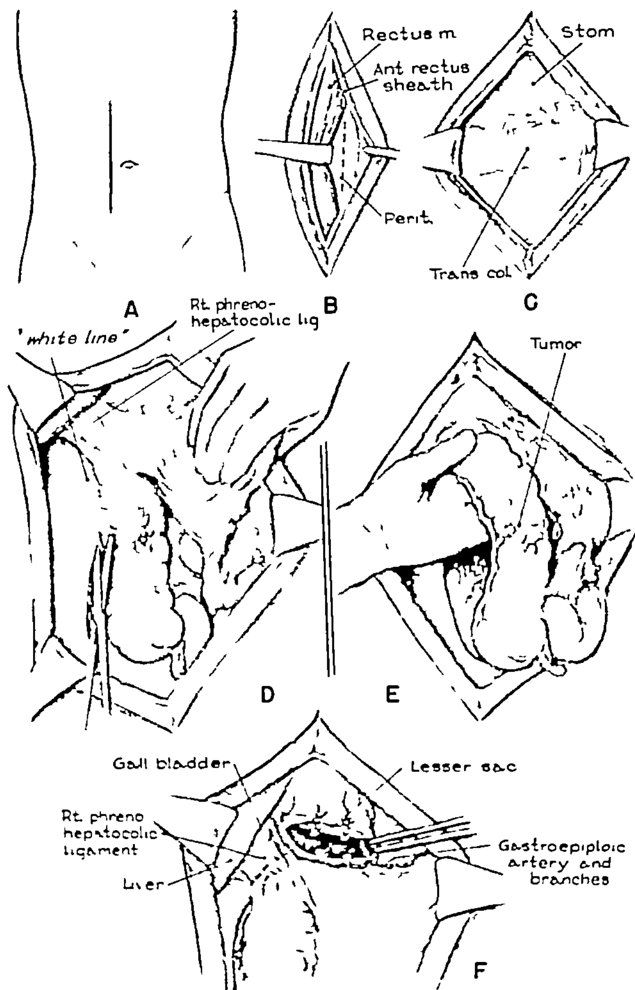
F The hepatic flexure and the right half of the transverse colon are mobilized by clamping and dividing the right phrenocolic ligament (dotted outline) and the anterior and posterior gastric branches of the gastroepiploic arch respectively The skeletonization of the distal half of the greater curvature of the stomach is done to include the adjacent gastrocolic ligament and greater omentum in the resected specimen. This insures the adequate removal of the lymphatic drain.

Discussion—Dr Howard A. Patterson It is in the right side of the colon that one finds many of the "bulky" neoplasms, which experience has shown to have a far better prognosis than some of the smaller types. A radical attack is often rewarded by cure, even when the abdominal wall or adjacent viscera are invaded.

Dr Madden has outlined, compactly but thoroughly the steps in the rather well standardized modern "right hemicolectomy" and he leaves little for the discusser to contribute by way of alteration or addition. It might be well to remind the surgeon that thorough exploration (by palpation) of the entire abdomen should *precede* local inspection of the colonic lesion, lest he become so fascinated with the excision as to forget the exploration entirely Then, too an abscess may be encountered alongside the lesion when least expected, which may make it unwise to proceed with exploration of the rest of the abdominal cavity

Exposure should be adequate and reasonably quick. I prefer an incision slightly more lateral than that shown in Plate 148 A, with division of the rectus in the same line rather than retraction of the muscle outward Retraction is tedious and limits exposure to some degree. An oblique right lower abdominal incision is an excellent alternate choice, as it affords enough exposure and is the "strongest" subsequently

If a cecal cancer is encountered unexpectedly during surgery for appendicitis (through a McBurney incision), access for a right hemicolectomy can be gained by extending the small incision medially and dividing the rectus sheath. The hepatic flexure is very


Rectus m
Ant rectus sheath
Perit.
Stom
Trans col
A
B
C
Rt. phreno-hepatocolic lig
'white line'
Tumor
D
E
Gall bladder
Lesser sac
Rt. phreno hepatocolic ligament
Liver
Gastroepiploic artery and branches
F

G The mobilization of the right side of the colon and the proximal half of the transverse colon is completed, and the stomach is retracted upward to expose the lesser sac and its related structures.

H The right side of the colon is retracted toward the midline, and the retroperitoneal structures which are to be identified and protected from injury during the mobilization of the colon are depicted. These structures are (1) the internal spermatic or ovarian vessels (2) the right ureter (3) the inferior vena cava, and (4) the retrocolic portion of the duodenum.

I The sites of election for transection of the ileum and transverse colon are encircled by traction tapes of rubber tissue inserted through openings in avascular segments of the mesentery in juxtaposition to the bowel wall.

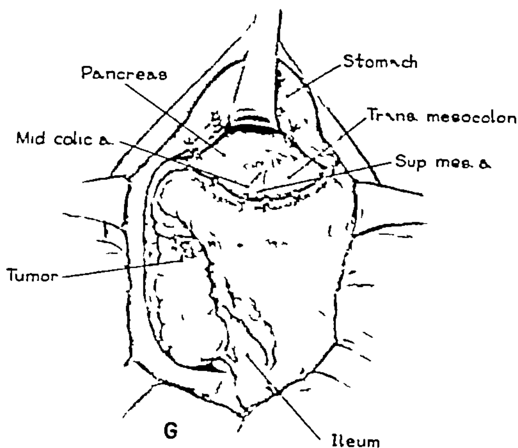
DISCUSSION—DR. PATTERSON (cont.)

rarely at as high a level as indicated in Plate 148 D E, and F and, on several occasions, I have easily removed the right colon through such an incision.

The division of the lateral peritoneum, as in D might well be at a site further removed from the growth If the neoplasm is adherent to the lateral wall, a row of Kocher clamps on the peritoneum and posterior sheath, rather than retractors, may be used. The surgeon may also wish to move to the left side of the table for a short while, to get a more direct look.

Warren Cole s work on the danger of implanting tumor cells in the needleholes of an anastomosis, and also on the possibility of squeezing tumor-cell emboli into the veins during operative handling of the tumor mass, surely deserves further attention and study Ligation of the bowel (with tape) near either end of the area to be excised, *before* mobilization of the specimen, should make it less likely for the colonic wall at the site of the anastomosis to become coated with desquamated tumor cells that may be implanted by a needle Similarly prompt ligation of the right colic vein might theoretically prevent a tumor embolus to the liver We may eventually know whether these refinements are really worthwhile.

The peritoneum and the thin fascia beneath it form a remarkably good barrier against direct extension, and the retroperitoneal duodenum is very rarely invaded by carcinomas of the right colon, even though they may lie side by side. When this invasion does happen, simple local excision of the obviously involved area of the duodenal wall gives extremely poor results. Hence, a more radical resection of the duodenum should be considered if a cure seems at all possible in any particular case.



Duodenum
Stomach
Kidney
Inf VC
Ureter
Psoas m.
Int sperm. v & a.
(ovarian)
H

I

G. The mobilization of the right side of the colon and the proximal half of the transverse colon is completed, and the stomach is retracted upward to expose the lesser sac and its related structures.

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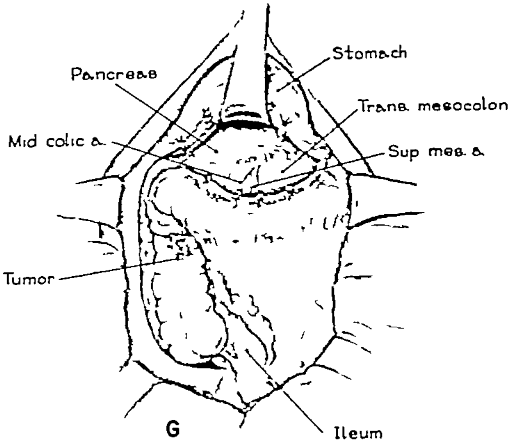
DISCUSSION—DR. PATTERSON (cont.)

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The division of the lateral peritoneum, as in D, might well be at a site further removed from the growth. If the neoplasm is adherent to the lateral wall, a row of Kocher clamps on the peritoneum and posterior sheath, rather than retractors, may be used. The surgeon may also wish to move to the left side of the table for a short while, to get a more direct look.

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The peritoneum and the thin fascia beneath it form a remarkably good barrier against direct extension, and the retroperitoneal duodenum is very rarely invaded by carcinomas of the right colon, even though they may lie side by side. When this invasion does happen, simple local excision of the obviously involved area of the duodenal wall gives extremely poor results. Hence, a more radical resection of the duodenum should be considered if a cure seems at all possible in any particular case.



Duodenum
Stomach
Kidney
Inf. VC
Ureter
H
I
Psoas m.
Int. sperm. v & a.
(Ovarian)

G The mobilization of the right side of the colon and the proximal half of the transverse colon is completed, and the stomach is retracted upward to expose the lesser sac and its related structures.

H The right side of the colon is retracted toward the midline and the retroperitoneal structures which are to be identified and protected from injury during the mobilization of the colon are depicted. These structures are (1) the internal spermatic or ovarian vessels, (2) the right ureter (3) the inferior vena cava, and (4) the retrocolic portion of the duodenum

I. The sites of election for transection of the ileum and transverse colon are encircled by traction tapes of rubber tissue inserted through openings in avascular segments of the mesentery in juxtaposition to the bowel wall.

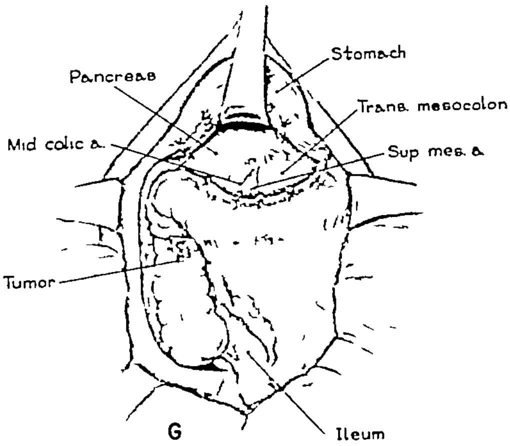
DISCUSSION—DR PATTERSON (cont.)

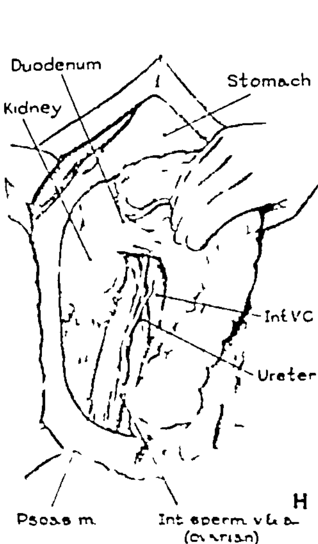
rarely at as high a level as indicated in Plate 148, D E, and F and, on several occasions, I have easily removed the right colon through such an incision.

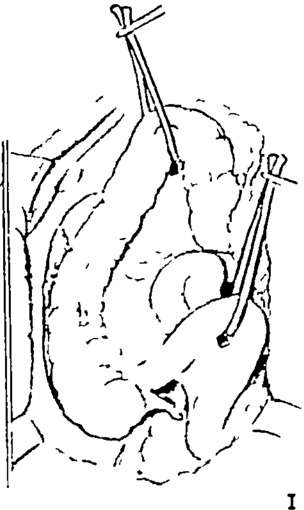
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Stomach
Pancreas
Trans. mesocolon
Mid colic a.
Sup mes. a.
Tumor
G
Ileum


Duodenum
Stomach
Kidney
Int VC
Ureter
H
Psoas m.
Int. sperm. v & a.
(ovarian)


I

J Incisions, as guide tracts for division of the mesentery are made through the serosal coverings of the transverse mesocolon and mesentery of the ileum to the respective sites of election for transection of the bowel. The apex of the incisions is at the level of origin of the right colic and/or ileocolic artery

J Inset to show the grouping of the mesenteric lymph nodes about the site of origin of the ileocolic artery from the superior mesenteric artery Accordingly in resection of the right side of the colon for carcinoma, the necessity for ligation of the right colic and/or ileocolic artery at their respective levels of origin to include the lymphatic drain is apparent.

K. The division of the mesentery is completed to the level of origin of the right colic and/or ileocolic arteries and hemostasis is obtained with suture ligatures of silk (000). The vascular pedicle is triply clamped prior to division between the two most distal clamps.

L, M. Insets to show method of occlusion of the vascular pedicle by a proximal ligature and a distal transfixing suture ligature of silk (00)

N The division of the mesentery of the ileum and the colon is completed, and the isolated ileocolic segment to be resected is demonstrated. For clarity the included segments of greater omentum and gastrocolic ligament are not shown.

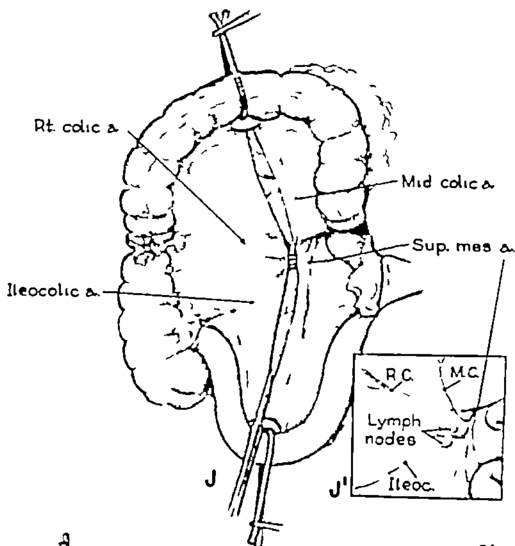
Discussion—Dr Patterson (cont.)

I agree heartily with Dr Madden's radical approach to the removal of lymph nodes and the right side of the omentum In this connection Plate 150, J and N and Plate 152, Z, are very helpful, though the young surgeon must be warned against too great enthusiasm. It is imperative that the superior mesenteric artery be *most* carefully safeguarded, and the pursuit of enlarged lymph nodes (Plate 150 J') may lead to damage or angulation of this artery with subsequent thrombosis. It is well known that the majority of enlarged nodes associated with cancer of the colon turn out to be inflammatory and not neoplastic, and it would be doubly tragic to lose a patient in pursuing these nodes too far However this warning should not be misinterpreted as condoning half hearted attack on the mesentery of the right colon.

There is little argument with the choice of end-to-end ileocolostomy as the quickest and best method of restoring continuity at the close of the resection. I have never liked the end-to-side method. At times, in the very old or debilitated patient, I still close both ends and do a side-to-side anastomosis, preferring to have three suture lines that could break and do *not*, to one that could and *does* However the end-to-end method is usually highly satisfactory and is advisable.

Peritonization of the posterior raw surface is usually difficult. I do not attempt it and have never had any reason to regret not doing so

The matter of establishing drainage is highly controversial. Multiple soft rubber drains may be brought out through a small flank incision and placed to the raw area. I am likely to use drainage in an obese patient, especially if the operation has been long and difficult, or there has been much inflammatory reaction in and about the tumor This is not in anticipation of a leak at the suture line (fortunately very rare) but to get rid of some contaminated bloody fluid. However this is probably an unnecessarily conservative approach, now that preoperative preparation of the colon is so greatly improved.



Duodenojejunal junction

K

L

M

N

O Noncrushing clamps (Babcock) are used to stabilize the segments of ileum and colon to be anastomosed, and crushing clamps are applied to the segments of bowel to be resected The level of transection of the bowel is in dotted outline. The area of resection includes the terminal 8 to 10 inches of ileum and the proximal portion of the transverse colon up to the site of bifurcation of the middle colic artery into its right and left branches. Routinely the right branch, and not infrequently the whole of the middle colic artery is included in the resection.

O′ Inset to show a close up of the mesenteric coapting suture of Lee.

P Guy sutures of silk are inserted through the lateral margins of the bowel wall, and the ileum is split along its antimesenteric surface to enlarge the diameter of its lumen at the site of anastomosis.

Q The first posterior layer of the anastomosis is completed, and the first anterior layer is commenced The central mattress suture for coaptation of the mesentery is visible The sutures anteriorly are inserted from the "inside out" to the "outside in" so that, when tied, the knots are on the inside of the lumen. Interrupted sutures of silk (000) are used throughout.

R. The first anterior inversion layer is completed, and the second anterior layer of seroserosal sutures (Lembert) is begun. A figure of 8 mattress suture indicates the termination of the closure in the center of the first anterior layer

S T Completion of the second layer of sutures anteriorly and the rotation of the bowel on its long axis to complete the second layer posteriorly are depicted.

U, U The completed end to-end ileotransverse colon colostomy and the approximation of the mesenteric borders viewed from behind and in front respectively No attempt to reperitonize the denuded area along the right posterolateral abdominal wall is made. Closure of the opening in the mesentery both anteriorly and posteriorly as depicted, is not required.

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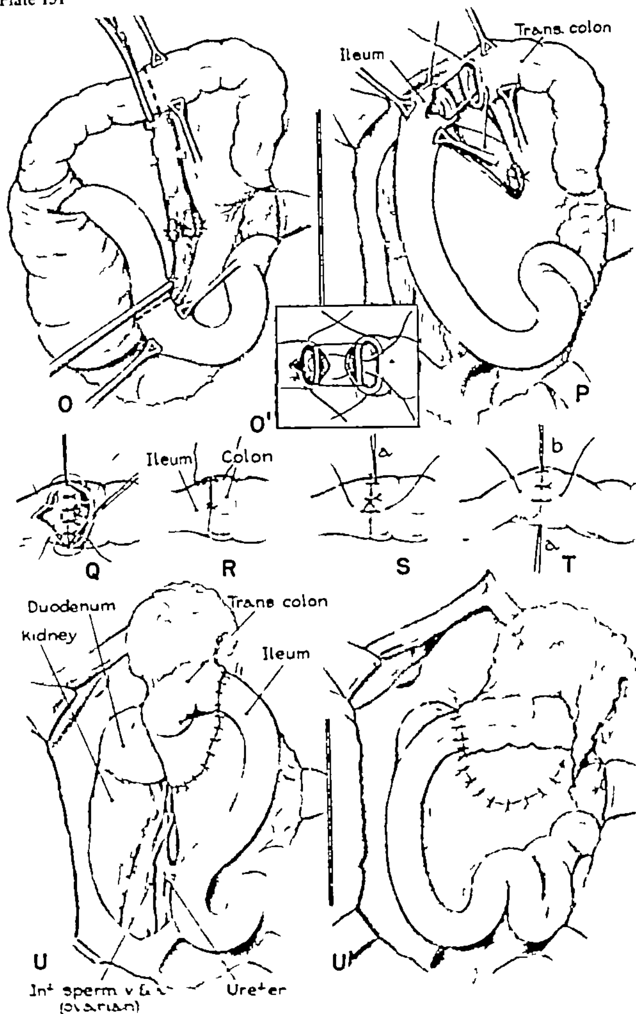
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Griffin, G D J Judd, E. S., and Gage, R. P Carcinoma of right side of colon. operability resectability and survival rates, Ann. Surg., 143.330, 1956.

Jamieson, J K., and Dobson, J R. The lymphatic system of the cecum and appendix, Lancet, 1 1137 1907

Plate 151



Ileum
Trans. colon
O
O'
P
Ileum
Colon
a
b
a
Q
R
S
T
Duodenum
Trans colon
Kidney
Ileum
U
U'
Int sperm v & v (ovarian)
Ureter

O Noncrushing clamps (Babcock) are used to stabilize the segments of ileum and colon to be anastomosed and crushing clamps are applied to the segments of bowel to be resected. The level of transection of the bowel is in dotted outline. The area of resection includes the terminal 8 to 10 inches of ileum and the proximal portion of the transverse colon up to the site of bifurcation of the middle colic artery into its right and left branches. Routinely the right branch, and not infrequently the whole of the middle colic artery is included in the resection.

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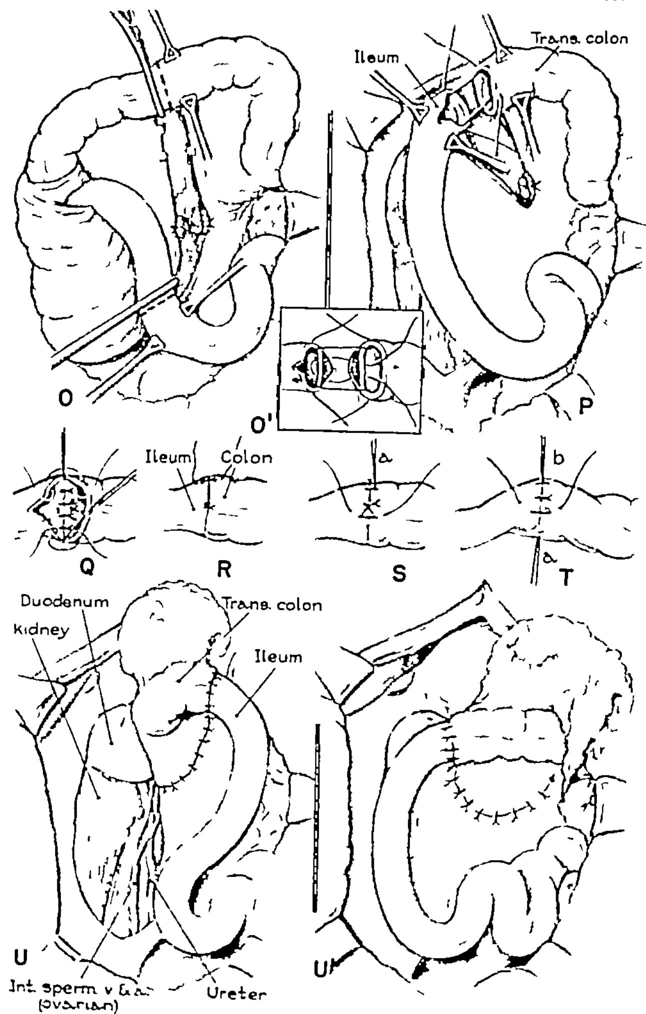
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Ileum
Trans. colon
O
O'
P
Ileum
Colon
a
b
a
Q
R
S
T
Duodenum
Trans. colon
Kidney
Ileum
U
Int. sperm v & a (ovarian)
Ureter
U'

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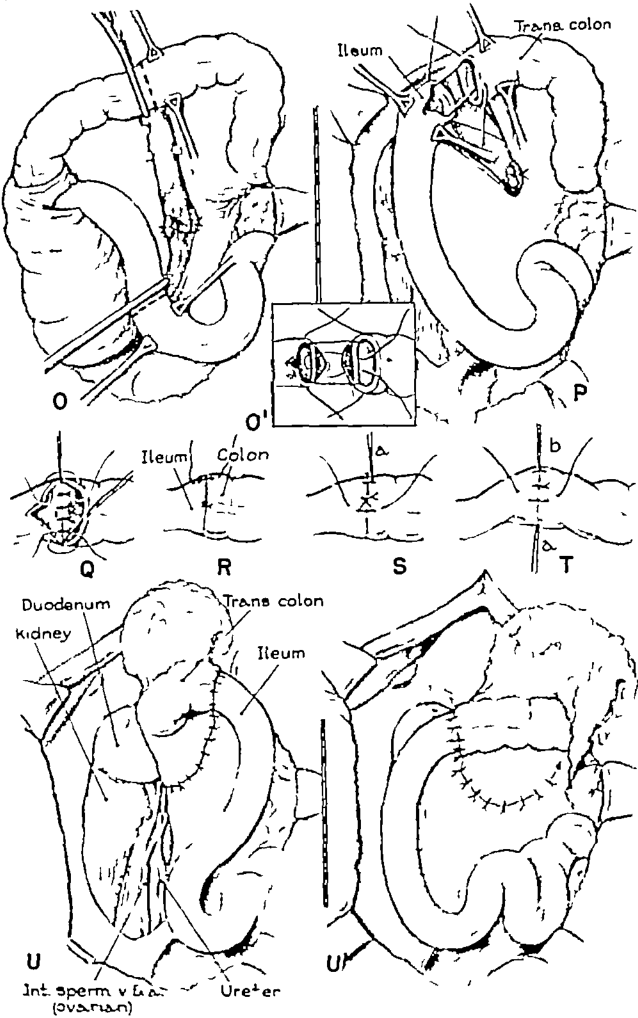
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Jamieson, J K., and Dobson, J R. The lymphatic system of the cecum and appendix, Lancet, 1 1137 1907


Ileum
Trans colon
O
O'
P
Q
Ileum
Colon
R
a
S
b
a
T
Duodenum
Kidney
Trans colon
Ileum
U
Int. sperm v & a.
(ovarian)
Ureter
U'

V W The approximation of the peritoneal layer with interrupted everting mattress sutures of silk (00) alternating with simple interrupted sutures, is shown.

X Y The fascial layer and skin are approximated with interrupted sutures of silk (00). In the closure of the skin the needles are first inserted and individually withdrawn, then the sutures are tied.

Z. *Diagrammatic representation of the extent* of bowel resection in the performance of a right hemicolectomy for carcinoma involving the right side of the colon.

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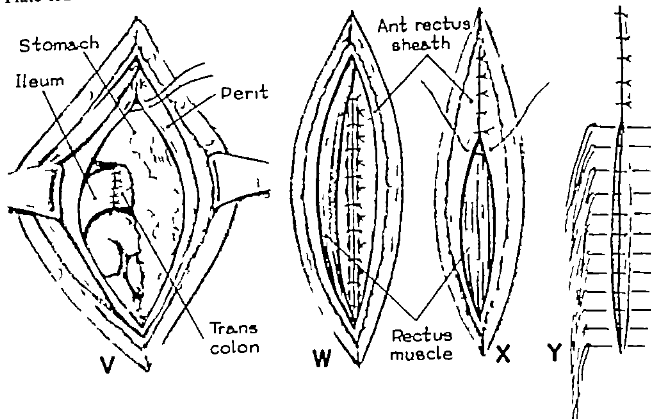
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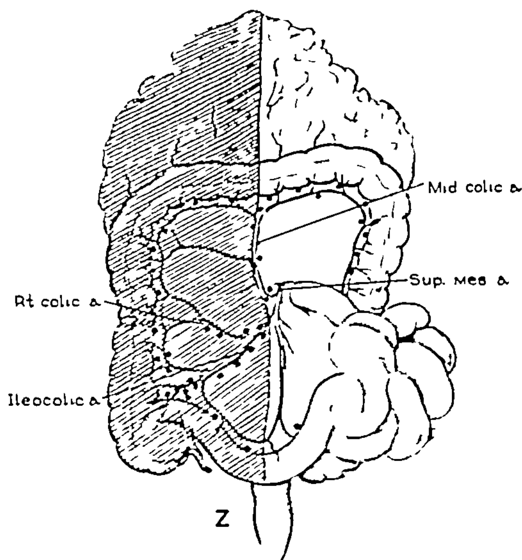
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Plate 152


Stomach
Ileum
Perit
Trans colon
V
Ant rectus sheath
Rectus muscle
W
X
Y


Mid colic a
Sup. Mes a
Rt colic a
Ileocolic a
Z

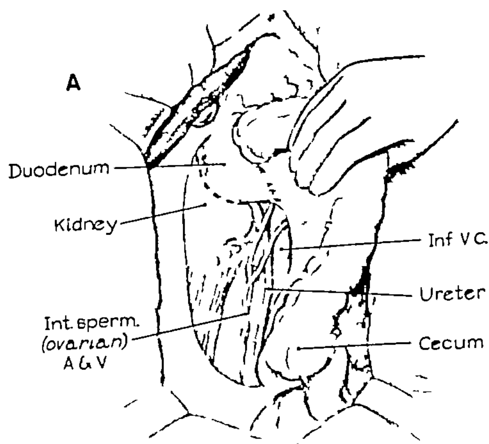
These illustrations depict the extension of the operation in the performance of a radical right hemicolectomy In lesions of the right side of the colon, retroperitoneal aortocaval lymph node dissection is now routinely performed. This dissection is the same as illustrated in the performance of Total Gastrectomy Splenectomy and Partial Pancreatectomy and Radical Left Hemicolectomy Furthermore, there is a sound anatomic basis for this dissection, relative to the removal of the lymphatic drain, in curative" operations for cancer of the rectosigmoid, the rectum, the testicle, the uterus, and the ovary In one patient, exploratory laparotomy and aortocaval node dissection was performed for metastatic lymphatic disease four and one-half years after radium and roentgen therapy for a Grade III carcinoma of the cervix. In a second patient who also had a Grade III carcinoma of the cervix, necropsy was performed five and one-half years after radium and roentgen therapy and extensive metastatic invasion of the aortocaval nodes was present. Accordingly in the radical "curative" operation for carcinoma of the cervix one questions the logic of limiting the resection of the lymphatic drain to the pelvic nodes. In such instances it is believed that aortocaval node dissection from the level of the renal veins downward, as illustrated, should be included.

A The mobilization of the right side of the colon is continued, and the related retroperitoneal structures are depicted The incision for the mobilization of the retrocolic portion of the duodenum is indicated in dotted out line

B The duodenum, previously mobilized by digital manipulation, is secured in a Babcock clamp and retracted upward to expose the enlarged aortocaval nodes invaded by metastases. The node constantly present behind the left renal vein the so-called "sentinel" node is visible

C. The remaining attachment of the aortocaval lymph nodal mass to the left lateral margin of the aorta is severed by scalpel dissection (dotted line) to complete the radical lymph adenectomy The uncovered aorta and vena cava and their related retroperitoneal structures may be clearly seen. The characteristic location of the terminal portion of the common bile duct between the lymph node laterally and the gastroduodenal artery medially is demonstrable.

Plate 153



B

C

Celiac axis

Duodenum

Aortocaval nodes

Pancreas

Com. iliac V & A

Inf mes A

RESECTION FOR CARCINOMA OF THE COLON IN THE REGION OF THE SPLENIC FLEXURE

In the surgical treatment of cancer of the colon, the extent of resection of the "lymphatic drain" is widely varied, depending upon the location of the primary lesion. The operation designed for cancer of the right side of the colon, including the proximal third of the transverse colon in general conforms with our knowledge of the lymphatic distribution. Un fortunately however the same does not obtain relative to the surgical treatment of tumors of the left side of the colon, including the distal third of the transverse colon. This applies in particular to carcinoma in the region of the splenic flexure, even though the inadequacy in the extent of resection in this region has been repeatedly emphasized.

In 1908 Clogg stated, "Any operation for cancer is not merely that of removal of the primary growth but also its lymphatic drain, as thoroughly as can be performed in ac cordance with the anatomy of the part." Clogg, and later Jamieson and Dobson, demon strated the presence of lymphatic communications between tumors in the region of the splenic flexure and the glands in the hilum of the spleen. Moynihan was fully cognizant of this when he stated, "Any operation destined to remove the whole lymphatic area at tached to the splenic flexure would, therefore appear to be impracticable in view of the possible enlargement in it of glands in the hilum of the spleen, unless the spleen itself is excised." In addition to the hilum of the spleen, the lymphatics of the splenic flexure have drainage to nodes in the transverse mesocolon, the mesentery of the descending and proximal sigmoid colon, the omentum, the gastrocolic ligament, and the tail of the pancreas

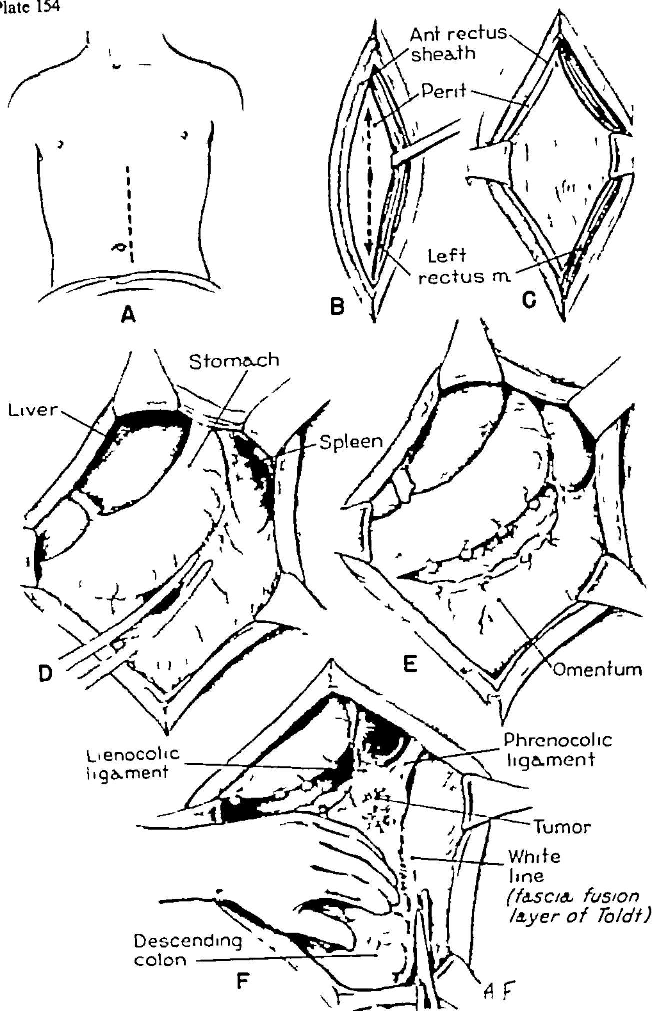
In the surgical treatment of carcinoma in the region of the splenic flexure, the adequate removal of its surrounding area of lymphatic drainage would embody the resection of the distal half of the transverse colon, the splenic flexure the whole of the descending and the proximal portion of the sigmoid colon, and the whole of the attached mesentery the distal half of the greater omentum, the proximal two thirds of the gastrocolic ligament, the spleen, and the tail of the pancreas. The technic for such an operation is shown in the following illustrations.

A B C. The peritoneal cavity is entered through a left rectus muscle retracting (lateral) incision. The incision extends from the apex of the left costoxiphoid angle downward to a level approximately 3 cm. below the umbilicus.

D E. The lesser sac is entered through an avascular area of the gastrocolic ligament above the gastroepiploic arch, and the gastrocolic ligament is serially clamped and severed to skeletonize and mobilize completely the proximal three fourths of the greater curvature of the stomach.

F The descending colon is retracted manually toward the midline and freely mobilized by scissor dissection along the line of peritoneal fusion, the fascia fusion layer of Toldt, commonly called the "white line."

Plate 154


Ant rectus sheath
Perit
Left rectus m
Stomach
Liver
Spleen
Omentum
Lienocolic ligament
Phrenocolic ligament
Tumor
White line (fascia fusion layer of Toldt)
Descending colon
A
B
C
D
E
F
A F

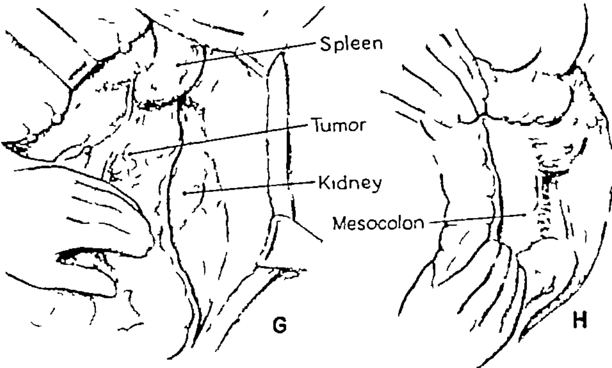
G. The mobilization of the colon is completed, first proximally to the region of the splenic flexure where the left phrenocolic ligament is severed, and then distally to the junction of the proximal and middle one third of the sigmoid.

H I. The dissection of the colon is continued medially to expose the lower pole of the *kidney the ureter the renal and spermatic* (or ovarian) veins, the aorta, and the site of origin of the inferior mesenteric artery

J The duodenojejunal junction is mobilized by severance of the ligament of Treitz and the mesentery adjacent. This permits the retraction of the duodenum and proximal portion of the jejunum which in tumors of the splenic flexure, is frequently displaced toward the site of the tumor by the foreshortened mesocolon.

K. The mobilization of the colon is completed, *and the pedicle of the spleen and the tail of* the pancreas are exposed anteriorly by clamping and severing the anterior layer of the gastrosplenic ligament and its contained vasa brevia.

Plate 155



Lt renal vein
Duodenojejunal junction
Aorta
Ureter
Sperm v
Inf mes.a
I
L Colic a.
J
Mesentery
Gastrosplenic lig & vasa brevia clamped
Pancreas
K

L, M. The spleen is manually retracted toward the midline, and the posterior layer of the lienorenal ligament is severed (dotted line) to expose the posterior aspect of the vascular pedicle and the tail of the pancreas The intimate relation between the tail of the pancreas and the pedicle of the spleen is apparent.

N A large, warm, moist, gauze pack is placed in the "splenic bed" and the spleen is reposited laterally The previously mobilized greater curvature of the stomach is retracted upward and medially to visualize the pancreas and the splenic vessels along its superior border The splenic vessels are triply clamped and severed between the two distal clamps.

O O[1] The two clamps proximally are replaced by a ligature and a suture ligature respectively of 00 silk, and the pancreas is transected subjacent to the site of severance of the splenic vessels. Hemostasis for the distal cut surface of the pancreas is obtained by the prior application of a large curved clamp and for the proximal cut surface by the serial application of Babcock clamps as the pancreas is transected The Babcock clamps compress the pancreas adequately for hemostasis without causing undue tissue trauma.

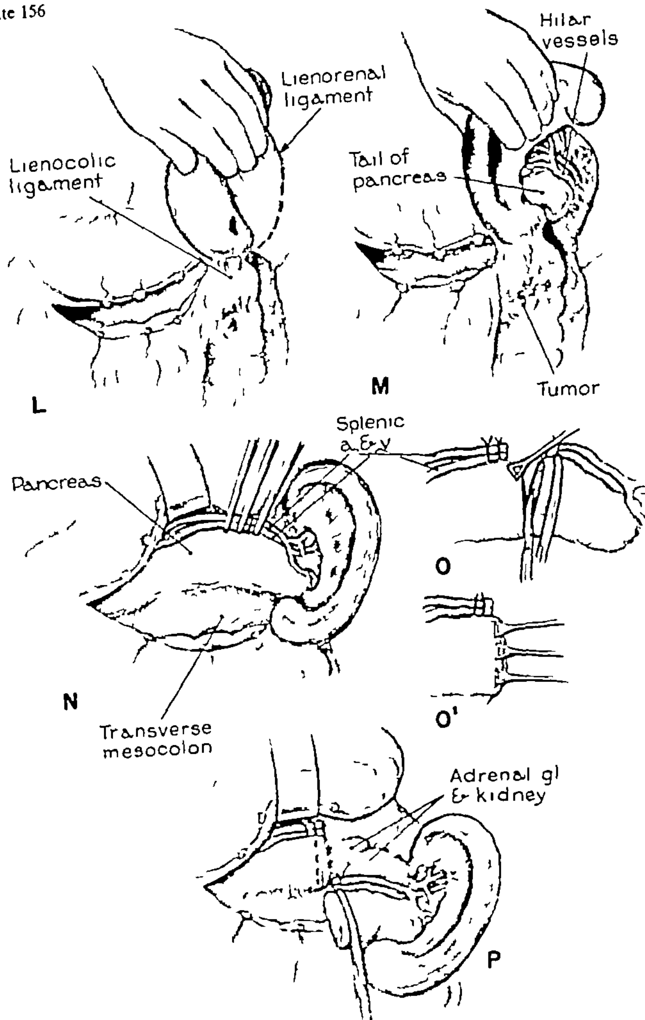
P The Babcock clamps have been replaced individually by mattress sutures of 00 silk, and the relation of the proximal cut end of the pancreas to the surrounding structures is depicted.

DISCUSSION—DR. J WILLIAM HINTON The illustrated technic for the Resection for Carcinoma of the Colon in the Region of the Splenic Flexure is most thorough for the finished surgeon. However since the presentations in the Atlas are primarily for those in surgical training, some emphasis should be placed on certain features relative to the operation advocated.

Surgeons who have had considerable experience in the treatment of cancer of the colon are aware that the methods of surgical management of the different malignant lesions in the region of the splenic flexure are varied Certainly the polypoid lesion with early malignant changes does not need as extensive an operation as the ulcerated carcinoma which extends through the wall of the intestine to involve the serosa. This type of lesion will unquestionably spread more frequently through the lymphatics than the annular type of carcinoma with stenosis. The annular carcinoma with stenosis does not require the same extensive and radical operation as the type of carcinoma that has involved the entire wall of the intestine.

I believe, from my own personal observations, that the emphasis for the trainee should be more on evaluating the pathologic process encountered and on a careful consideration of the age and general physical condition of the particular patient than on a standard operative procedure for all patients. It is also believed much more difficult to teach judgment as applied to an individual patient than to teach the technic for the performance of a particular operation. I do believe, however that the operative technic illustrated is of real value for the trained and experienced surgeon.

Plate 156


Lienorenal ligament
Lienocolic ligament
L
Hilar vessels
Tail of pancreas
M
Tumor
Splenic a & v
Pancreas
N
Transverse mesocolon
O
O'
Adrenal gl & kidney
P

Q R. The spleen and the severed distal segment of the pancreas are encased in a large, moist, gauze pad, and the mesocolon is serially clamped and cut opposite the site of election for transection of the colon. For the purpose of clarity the apron of greater omentum and gastrocolic ligament included in the resection is not shown In cutting the distal portion of the mesocolon, the left colic artery is doubly clamped just beyond its origin from the inferior mesenteric artery The inferior mesenteric artery is cleanly dissected as a routine, and, if indicated, it may be sacrificed with impunity

S T Prior to transgression of the continuity of the colon, the operative field is declared contaminated and is defined by the use of an appropriate red colored drape. To avoid unnecessary trauma to the tissues at the site of the anastomosis, Babcock clamps are employed to secure the proximal portion of the transverse colon and the distal segment of the sigmoid colon respectively Medium sized crushing clamps (Payr) are applied to the colon in juxtaposition to the Babcock clamps and the colon is transected as indicated in dotted outline.

U The operative field after the en bloc resection is shown The divided ends of the colon are held in approximation preparatory to the performance of a two layer end-to-end, open type of anastomosis using interrupted sutures of fine (000) silk. The open technic is preferred to the closed or so-called "aseptic" method of anastomosis

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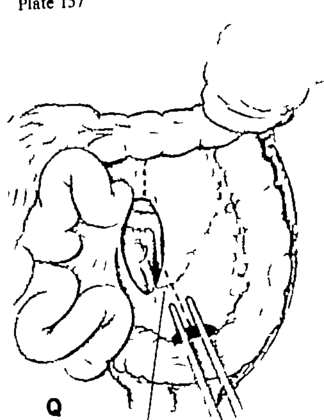
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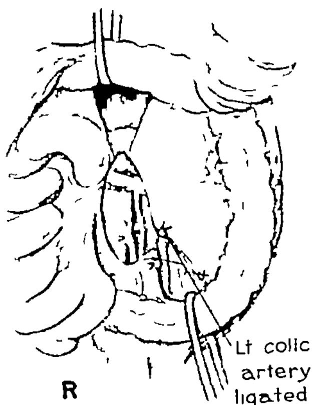
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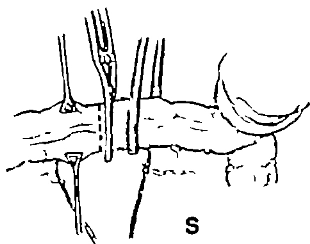
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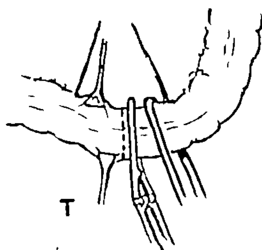
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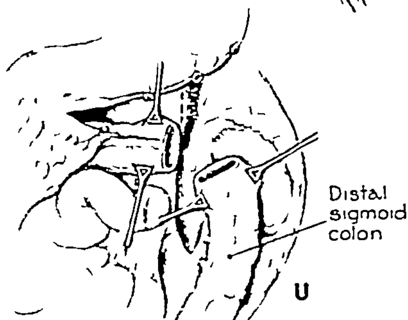
Plate 157


Q
Lt Colic a


R
Lt colic
artery
ligated


S


T


Distal
sigmoid
colon
U

V V_1 The segments of the colon are approximated with two guy sutures (000 silk) and the insertion of the first posterior layer of interrupted silk (000) sutures is completed.

V_2 The first anterior layer of sutures is inserted from the "inside out" to the "outside in" to place the knots on the inside of the lumen when the sutures are tied

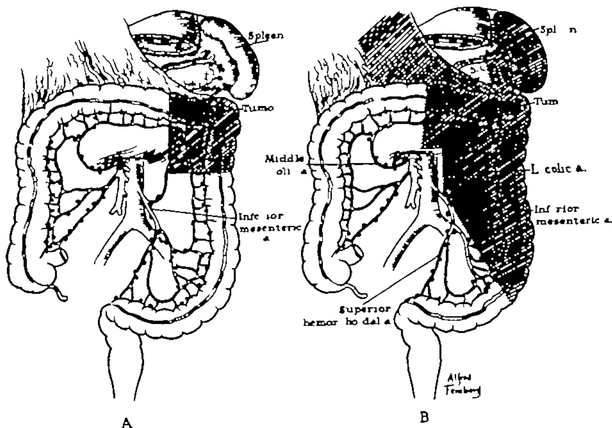
V_3 V_4. The second layer of the anastomosis is completed anteriorly using mattress sutures (Halsted) of fine (000) silk.

V_5. The two lateral mattress sutures anteriorly are left long to facilitate the rotation of the bowel on its longitudinal axis and the insertion of the mattress sutures (Halsted) posteriorly It is technically more feasible to insert the posterior layer of seromuscular sutures at the termination rather than at the beginning of the anastomosis

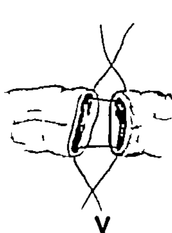
W The relation of the completed end to-end colocolostomy to the transected segment of the pancreas is demonstrated. The attachment of the proximal segment of the colon to the peritoneum overlying the pancreas as shown is not necessary

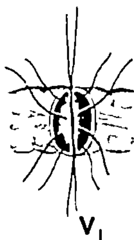
X. The operation completed, the contaminated drapes, gloves, and instruments are discarded, and the operative field is again declared sterile. A Penrose (cigarette) drain is placed in the retroperitoneal area adjacent to both the anastomosis and the transected end of the pancreas, and a layer closure of the wound is performed.

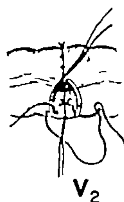
Y Z. The wound closure, using interrupted everting mattress sutures of silk (000) for the peritoneum, interrupted figure of 8 mattress sutures of silk (000) for the fascia, and simple interrupted sutures of silk (000) for the skin, is shown.

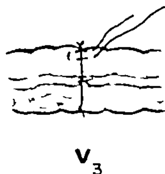


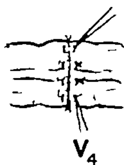
Diagrammatic illustrations of the extent of resection (shaded areas) in the surgical management of carcinoma of the colon in the region of the splenic flexure A. The comparatively small V shaped segment of colon that is so frequently resected. B. The extent of the resection as depicted in the preceding illustrations to include the potential zone of "lymphatic drain.

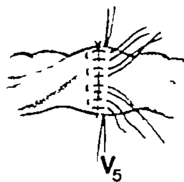

V

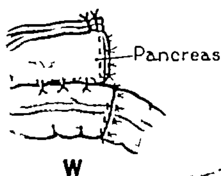

V1

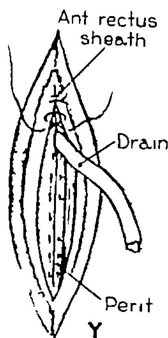

V2

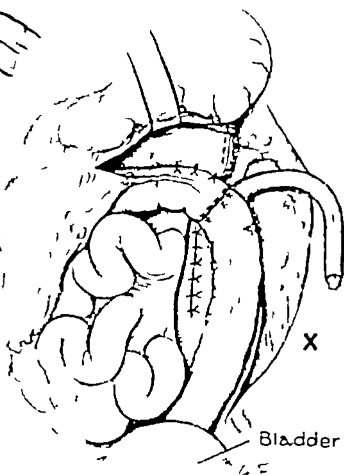

V3

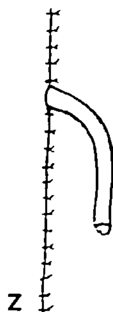

V4


V5


Pancreas
W


Ant rectus
sheath
Drain
Perit
Y


X
Bladder


Z

RADICAL LEFT HEMICOLECTOMY

A B C. The peritoneal cavity is entered through a left rectus paramedian muscle splitting incision, and the tumor and the lower portion of the descending colon are exposed.

D. The colon, covered with a moist gauze pad and manually displaced toward the midline, is mobilized by scissor dissection along the fascia fusion layer of Toldt, commonly called the "white line."

E. To facilitate the mobilization of the splenic flexure, the lesser sac is entered through the gastrocolic ligament, and the greater curvature of the stomach is mobilized by serially *clamping and severing the gastrocolic liga*ment cephalad to the gastroepiploic arch. This is perferred to entering the lesser sac by dissection of the omentum from the transverse colon since it permits the removal of the attached omentum and the gastrocolic ligament with the resected specimen.

F. The mobilized segments of the transverse and the descending colon are approximated, and, with downward traction maintained, the splenic flexure is mobilized by severance of the left phrenocolic and splenocolic ligaments. In some instances, because of its vascularity it may be necessary to clamp the splenocolic ligament before it is severed.

G. The mobilization of the left side of the *colon is completed to the middle third of the* transverse colon, and several of the related retroperitoneal structures are depicted.

DISCUSSION—DR. FREDERICK H. AMENDOLA. In several respects the illustrated technic for the left hemicolectomy is somewhat more radical than the operation that is generally performed. The surgical approach is well conceived, and it is quite possible that it offers, to the patient for whom it is appropriate, a better chance of cure than the less extensive procedures commonly employed. However any added advantage which might accrue from excursion upward under the duodenum, pancreas, and left renal vein may be outweighed on certain occasions, and particularly in obese or otherwise unsuitable subjects, by the added risk that such dissection undoubtedly creates. In extirpating regional node metastases, one must inevitably reach the point of diminishing returns and, considering the fact that mesenteric venules certainly assist in the dissemination of a considerable proportion of colon cancers, it is my feeling that this critical point is reached sooner than we think. Therefore, in deciding whether to employ a radical operation in a given patient, we must be ever mindful of the possible complications that the greater procedure entails, and we must be reasonably certain that the increased hazard is justified by improved long-term results.

The technical aspects of the radical operation are

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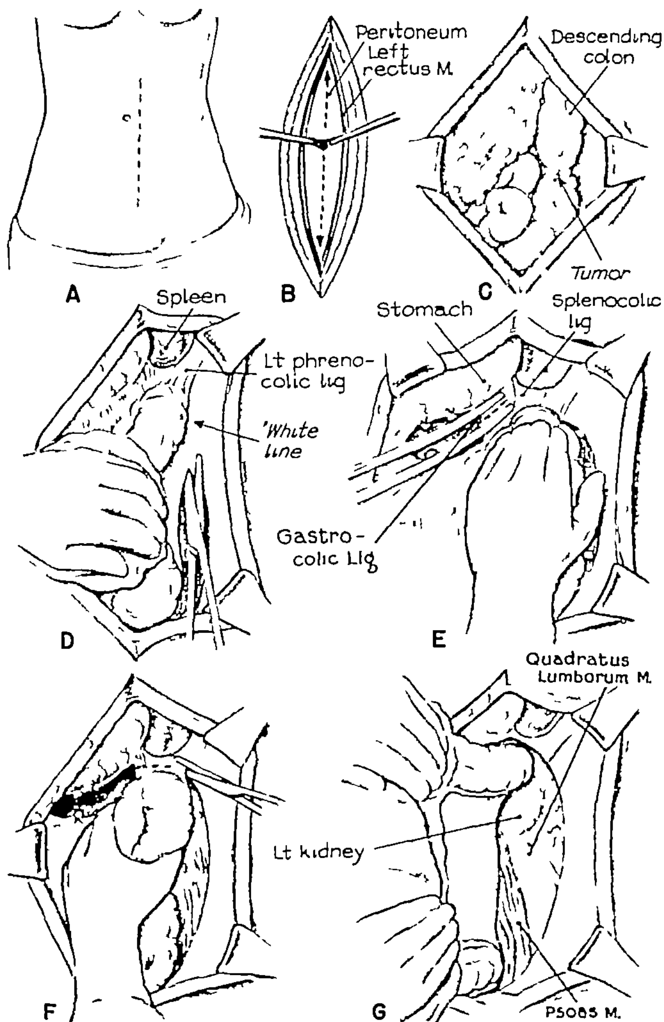
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Peritoneum
Left rectus M.
Descending colon
Tumor
A
B
C
Spleen
Lt phreno-colic lig
'White line
D
Stomach
Splenocolic lig
Gastro-colic Lig
E
Quadratus Lumborum M.
Lt kidney
Psoas M.
F
G

H. The left side of the colon is further retracted medially to show more completely the related retroperitoneal structures. The relation of the left ureter to the bifurcation of the common iliac artery is visible The enlarged lymph nodes overlying the anterior surface of the aorta in relation to the inferior mesenteric artery may also be seen.

I, J The presacral space is entered by scissor dissection, and the rectosigmoid segment of the colon is mobilized by digital manipulation from the hollow of the sacrum.

K. The mobilization is completed posteriorly and by maintaining traction upward on the colon the recto-uterine fossa (Douglas) and the surrounding structures are shown.

L. The mobilized left side of the colon is reposited laterally and a rubber catheter (14 F) is inserted through an avascular portion of the transverse mesocolon at the site of election for severance of the transverse colon. The transverse mesocolon is partially severed by scissor dissection along the inferior border of the pancreas where the peritoneal layers separate to cover this gland.

DISCUSSION—DR. AMENDOLA (cont.)

shown clearly and accurately in the illustrations. The incision (Plate 159 A) might usefully be extended a few inches higher toward the costal margin. Mobilization of a deeply placed splenic flexure can be difficult and time consuming, and if exposure is inadequate, the serosa of the lower pole of the spleen may be stripped inadvertently and necessitate splenectomy for control of obstinate oozing. Before the descending colon is too extensively mobilized, it might be well to place ligatures around the bowel immediately above and below the lesion, as suggested by Warren Cole Exfoliated tumor cells will thus be trapped within this segment and the likelihood of their implantation in the anastomotic suture line will be appreciably reduced.

Excision of the portion of the greater omentum (Plate 159 E) that is attached to the segment of transverse colon to be removed is sound. The alternative method, leaving the omentum behind after dissecting it away from the transverse colon, is acceptable only in the excision of benign or inflammatory lesions.

For tumors of the descending colon or high sigmoid it should not often be necessary to mobilize the rectosigmoid segment as indicated in Plate 160, I and J For lesions in the lower sigmoid this maneuver is

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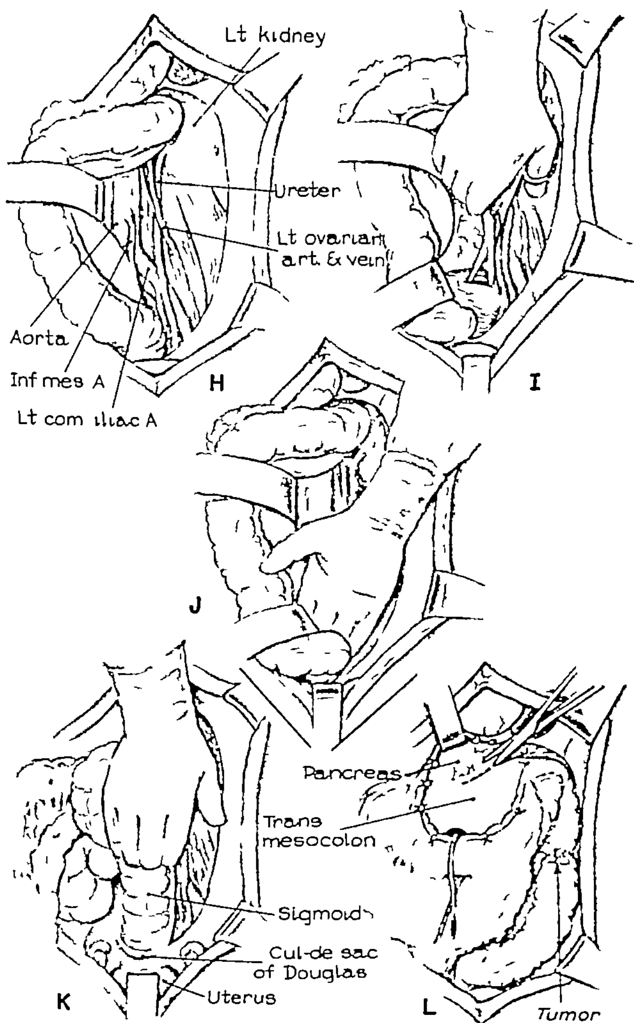
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Lt kidney
Ureter
Lt ovarian art. & vein
Aorta
Inf mes A
Lt com iliac A
H
I
J
Pancreas
Trans mesocolon
Sigmoid
Cul-de sac of Douglas
Uterus
K
L
Tumor

H. The left side of the colon is further retracted medially to show more completely the related retroperitoneal structures. The relation of the left ureter to the bifurcation of the common iliac artery is visible. The enlarged lymph nodes overlying the anterior surface of the aorta in relation to the inferior mesenteric artery may also be seen.

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K. The mobilization is completed posteriorly and by maintaining traction upward on the colon the recto-uterine fossa (Douglas) and the surrounding structures are shown

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DISCUSSION—DR. AMENDOLA (cont.)

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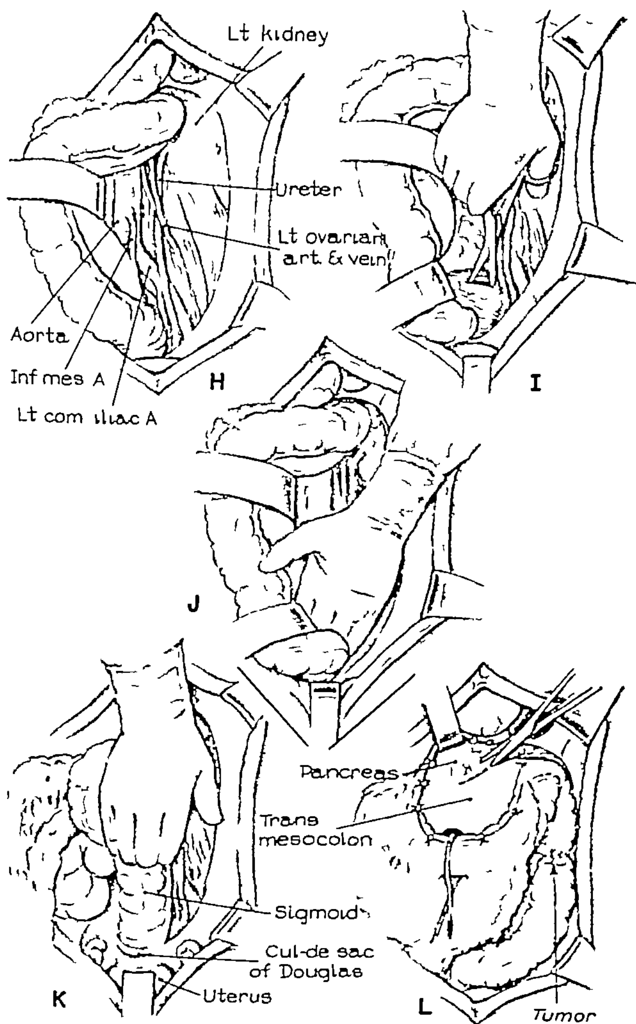
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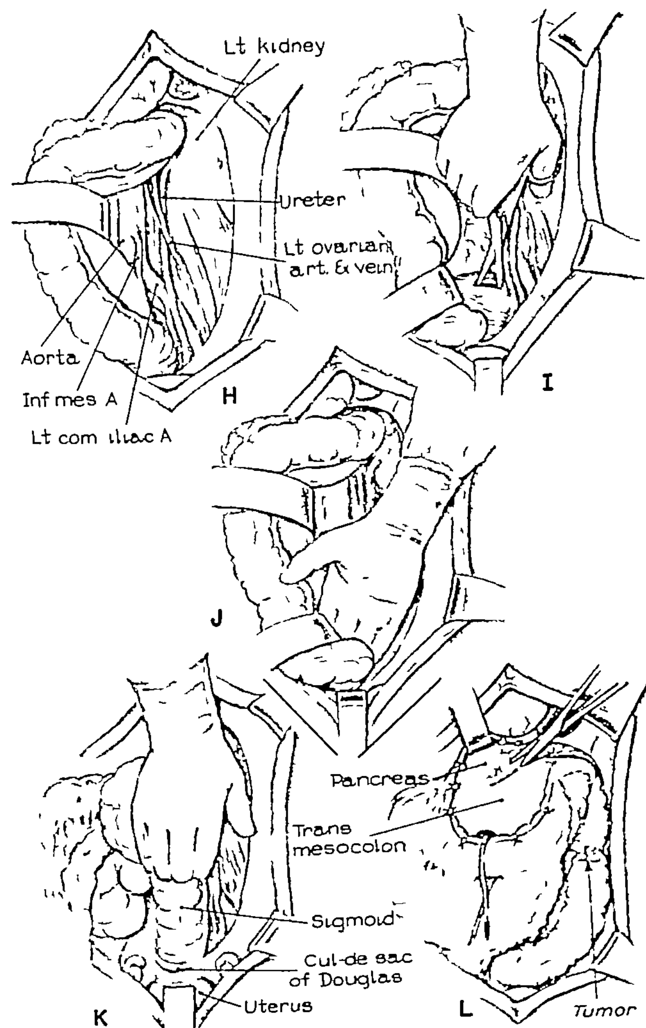
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Lt kidney
Ureter
Lt ovarian art. & vein
Aorta
Inf mes A
Lt com iliac A
H
I
J
Pancreas
Trans mesocolon
Sigmoid
Cul-de sac of Douglas
Uterus
K
L
Tumor

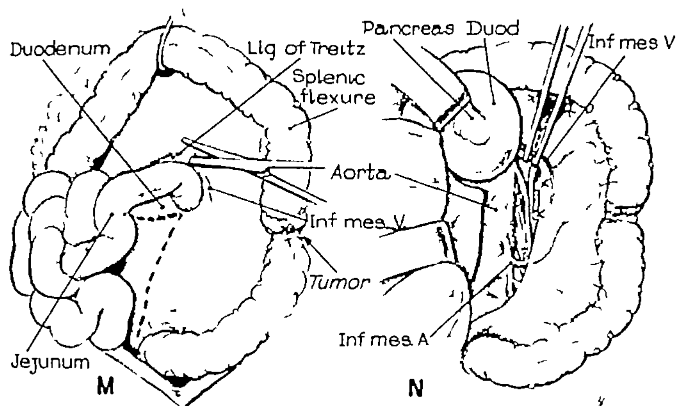
M. The transverse colon is displaced upward by traction, and the ligament of Treitz is severed with scissors. The close relation of the inferior mesenteric vein to the duodenojejunal junction is visible. Exposure of both the aorta and the inferior vena cava is obtained through incisions along the attachment of the root of the mesentery of the small bowel and the peritoneal covering of the inferior border of the transverse portion of the duodenum as shown by the dotted lines. If desired the incision along the root of the small bowel mesentery may be continued around the cecum and then upward along the right side of the colon to mobilize completely this segment of the large bowel. The mobilized small and large bowel is then inserted into a Lahey type rubber bag and placed on top of the upper portion of the abdomen. This type of mobilization has been performed when indicated to improve the surgical exposure. If used one must be certain that hemostasis is complete relative to the mobilized segment of the right side of the colon. Otherwise excessive blood loss (800 to 1000 ml.) into the bag may occur. Occult hemorrhage of this nature was observed on two occasions.

N. The mobilized small intestine is covered, first with a large piece of rubber tissue dam and then with a moist gauze pad before it is retracted from the operative field. The aorta and the enlarged lymph nodes on its anterior surface are now more clearly seen. The transverse mesocolon, subjacent to the site of election for severance of the transverse colon, is serially clamped and severed, and the inferior mesenteric vein is doubly clamped at the apex of the paraduodenal fossa prior to its severance.

O P The operative field is more widely exposed by further retraction of the small bowel and its mesentery in conjunction with the mobilization of the whole of the duodenal loop and the head of the pancreas. The mass of matted nodes and lymphatic tissue about the aorta and inferior vena cava is completely exposed. A node that is constantly present and referred to as the "sentinel" node is located on the front of the aorta just behind the junction of the left renal vein with the inferior vena cava. Elevation of the left renal vein (P) is required for the exposure and removal of this node. In its removal caution should be observed to prevent injury to the adjacent right renal artery.

The surgical importance of the mobilization of the duodenum and the head of the pancreas in the performance of the retroperitoneal node dissection should be emphasized. Normally the inferior border of the duodenum overlies the aorta at the level of origin of the inferior mesenteric artery. In fact, in some instances the origin of this artery may be seen only after the duodenum is mobilized and elevated. Accordingly, if the cephalad portion of the retroperitoneal dissection is limited to the level of the inferior border of the duodenum, the lymphatic tissue and nodes overlying a long segment (7 to 8 cm.) of the aorta and inferior vena cava, which may be either invaded or potentially invaded by metastatic disease, are not included in the dissection. This is obviated by mobilizing and retracting upward the duodenum and the head of the pancreas. The illustrations depict clearly the extent of the exposure of both the aorta and the vena cava proximal to the level of origin of the inferior mesenteric artery when this is done.

Q The removal of the group of aortacaval lymph nodes is commenced by sharp dissection. A short segment of the inferior mesenteric artery and its origin from the aorta may also be seen.



Inf vena cava
Pancreas
Renal V
Aortocaval lymph nodes
Lt ovarian art. and vein
Rt ovarian art. & vein
Com. iliac A
O
P
Inf mes. A
Mass of aortocaval lymph nodes
Q

R, S. The retroperitoneal dissection is continued, and the mass of lymphatic tissue and contained lymph nodes is peeled down off of the inferior mesenteric artery. This artery is first ligated proximally (silk, 00) at its origin and then doubly clamped as shown prior to its severance. To secure hemostasis a suture ligature of silk (00) is inserted through the proximal stump of the severed artery immediately distal to the first occluding ligature (S). In utilizing this technic of exposure of the inferior mesenteric artery by tissue dissection from above downward, that is from behind, the likelihood of cutting across lymphatics laden with cancer cells is lessened. On the contrary this likelihood is increased when the inferior mesenteric artery is exposed by tissue dissection from in front at the level of its origin from the aorta.

T. Following the completion of the ligation and division of the inferior mesenteric artery scalpel dissection is continued and the aortacaval lymphatic mass is removed from the common iliac vessels.

U. The mobilized lymphatic mass is reposited temporarily onto the aorta and the vena cava, and preparations are made for the resection of the left side of the colon. The proximal segment of the transverse colon is secured with two Babcock clamps and the distal segment is occluded with a straight crushing type clamp (Kocher). The site of division of the colon is indicated by the oblique dotted line. The mesosigmoid subjacent to the site of election for transection of the bowel distally is doubly clamped prior to its severance.

V. The operative field is declared contaminated, and it is walled off with a red colored laparotomy sheet. The transverse colon is severed and the distal cut end is covered with a moist gauze pad. For clarity the temporary covering of the proximal open end of the colon is omitted. The lower portion of the sigmoid colon is occluded proximally with a straight crushing clamp (Kocher) and secured by two Babcock clamps distally preparatory to its transection as indicated by the dotted line. Following the resection of the colon the dissection of the lymphatic mass is continued along the external iliac vessels to the inguinal ligament and removed en bloc.

DISCUSSION—DR AMENDOLA (cont.)

of course, indispensable and very useful in affording needed length in the distal limb.

In Plate 161 the steps suggested for excision of proximally placed pre aortic nodes are illustrated. These steps must be executed with great care if troublesome bleeding is to be avoided. In a patient who is overweight a thick deposit of retroperitoneal fat in this strategic area may make dissection difficult. In the average subject I have usually been content to divide the inferior mesenteric artery as close to its origin at the aorta as good ligation permits. This frequently requires mobilization upward of the inferior border of the duodenum. I have not pursued the chain of pre aortic nodes as high up under the left renal vein as the illustrations indicate. Involvement of the nodes at that level would be very ominous, but I see no reason why extirpation of such nodes should not be attempted under *suitable* conditions. Removal of all nodes and areolar tissue situated around the origin of the inferior mesenteric artery and distally from the aorta and vena cava (Plate 162, S and T) is essential and, in some respects, more important than the excision of tremendous lengths of bowel above and below the lesion. I have always felt that the really significant step in the performance of an adequate resection for carcinoma of the colon is accomplished by removing the *central areas* of lymphatic spread—that is, the nodo-bearing tissue about the origin of the vessel which is to be sacrificed—and a generous but reasonable segment of mesentery and bowel above and below the growth.

The illustrations U and V, Plate 162, show the tumor bearing segment being excised. It might be a helpful suggestion to the operator that the transverse colon be divided at a point that permits its easy approximation to the sigmoid loop without tension. This point may be selected by testing before actual transection is done. An additional few inches of length will often facilitate the approximation immeasurably. When I have resected a long segment of transverse colon, I have found it necessary on a number of occasions to mobilize the hepatic flexure to avoid tension on the suture line. Because of the frequency of multiple tumors in the colon, it might be wise to introduce a sterile sigmoidoscope into the open limbs of bowel before the anastomosis is performed. The presence of a small unsuspected carcinoma or polyp may be disclosed by this simple maneuver.

Plate 162

Lt renal A&V
Inf mes A
Ligated stump of inf mes A.
R
S
T

Lt kidney
Transverse colon
Lt renal A &V
Tumor
Sigmoid
U
V

W The operative field following the completion of the radical left hemicolectomy and retroperitoneal lymph node dissection is shown The proximal end of the transverse colon will be united with the distal segment of the sigmoid colon by an open type end to-end anastomosis.

X X[1] Guy sutures of silk (000) are inserted through the lateral margins of each segment of large bowel and the first posterior layer of the anastomosis, using interrupted sutures of silk (0000), is completed.

X[2] X[3] X[4] The second posterior suture layer a continuous interlocking suture of chromic catgut (00) is inserted and continued anteriorly as a Connell ("loop on the mucosa") type of suture (*a*) This suture *a* which forms the first anterior layer of the anastomosis is inserted from the "outside in" to the "inside out" and "over" to invert the bowel wall and obtain a serosa to-serosa approximation A second chromic catgut suture *b* is commenced at the opposite angle of the anastomosis and is continued as the first suture layer anteriorly similar to *a* to avoid an angle closure of the suture line.

X[5] X[6] The two inversion sutures forming the first anterior layer are terminated in the midline opposite each other Each of these sutures is in turn inserted through the bowel wall on the opposite side from the "inside out" (X[6]) and then tied together (X) to complete the first layer of the closure anteriorly

X[7] X[8] *The second layer anteriorly (a') con*sists of a series of interrupted mattress sutures of the Halsted type which, if warranted, may be continued as an additional reinforcing suture layer posteriorly (X[8]).

Y The operative field and the related structures after the completion of the end to-end colocolostomy are demonstrated. The drain in the retroperitoneal space, in close approximation to the anastomosis, is brought out through the abdominal incision rather than through a stab wound toward the flank.

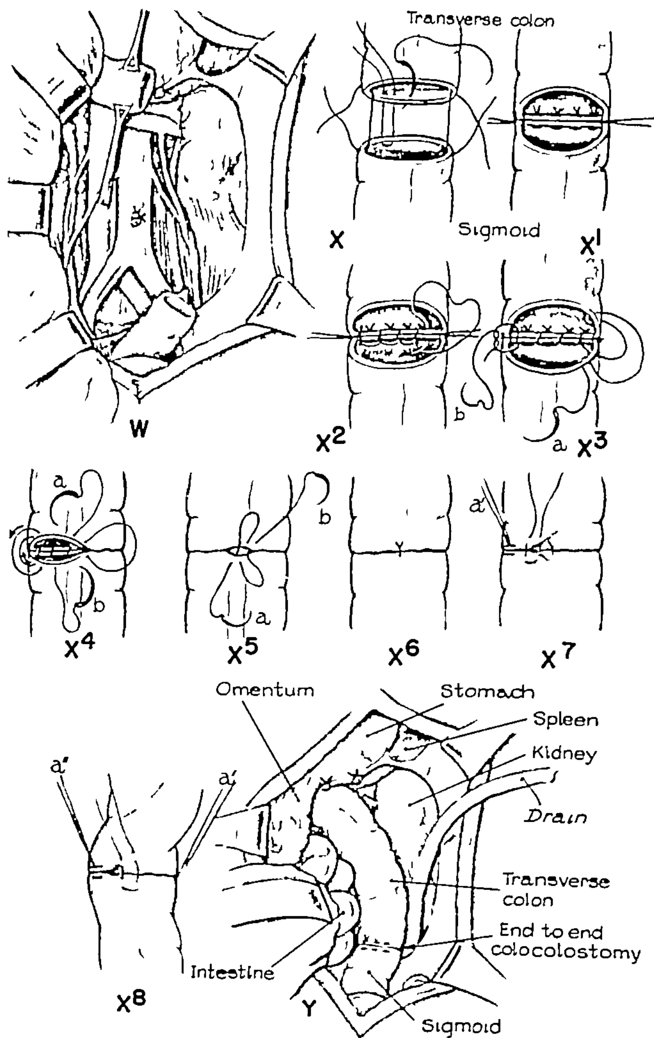
Discussion—Dr Amendola (cont)

The illustrations in Plate 163 show in detail the technic of the anastomotic suture Dr Madden employs two layers of sutures I have always preferred a single layer of carefully placed Halsted sutures of 0000 silk However whichever method one does employ it is important to remember that excessive inversion of the line of closure may produce dangerous narrowing of the lumen at the stoma At the conclusion of the anastomosis, the patency and adequacy of the stoma should be tested carefully with the thumb and forefinger

The operator should be reminded of the importance of closing the mesenteric defect following any form of intestinal resection in order that internal herniation of the small bowel be avoided.

The need of placing a drain routinely at the site of the anastomosis is, in my opinion, open to question. There can be no reasonable objection to drainage of a widely denuded retroperitoneal area although I believe that even this is unnecessary On the other hand, I have always introduced a drain down to the anastomosis in the pelvis when I have united a proximal loop of bowel covered by serosa to a distal loop that was not so protected. That there is always some insecurity about an anastomosis done at so low a level is amply demonstrated by the appreciable incidence of local leakage and fistula formation following so-called anterior resection for a very low sigmoid lesion.

I am in complete agreement with Dr Madden that our resections for carcinoma of the colon must be planned to encompass, at the first procedure those regional nodes that might harbor cancer cells. This must be done, however within reasonable limits of safety In the final analysis the estimation of risk involved in an extended procedure in a specific patient must be left to the judgment of the responsible surgeon.


Transverse colon
Sigmoid
W
X
X1
X2
X3
a
b
a
b
X4
b
a
X5
X6
a'
X7
Omentum
Stomach
Spleen
Kidney
Drain
a'
a'
Transverse colon
End to end colocolostomy
Intestine
X8
Y
Sigmoid

ANTERIOR RESECTION OF THE RECTOSIGMOID COLON

In the performance of an anterior resection of the rectosigmoid colon the preliminary phases of the operation are the same as those used in the abdominal phase of the one-stage combined abdominoperineal resection of the rectum and are depicted in the illustrations of that operation, A through S

A. Traction is maintained upward on the sigmoid colon, and traction sutures of silk and a right angle clamp respectively are applied to the rectal wall below the level of the tumor The site for the transection of the rectum is shown by the dotted line. For clarity the tumor mass is uncovered.

B. The transection of the rectum is completed, and the site for severance of the sigmoid colon proximally is shown. Crushing clamps are not applied to either segment of the bowel that is used for the anastomosis. The open type of anastomosis, using interrupted sutures of silk (00), is preferred

C. Lateral angle approximation sutures are inserted, and the lumen of each bowel segment is irrigated with copious quantities of warm (112 F) isotonic saline solution, which is immediately removed by suction siphonage. This is done for the purpose of washing away any desquamated tumor cells that may be present and thereby tends to lessen the incidence of tumor recurrence at the anastomotic site

D. The first suture layer posteriorly is completed. This layer consists of interrupted through and through sutures of silk (000) which are first all inserted, tied individually and then cut.

D Inset to show an alternate and frequently preferred method for the closure posteriorly A series of interrupted horizontal mattress sutures are inserted as the first posterior layer This causes an eversion of the cut margins of the bowel which are approximated by a continuous suture of fine chromic (00) catgut, either as a simple over and over suture as shown, or one of the interlocking type. This suture the second layer posteriorly is then continued anteriorly as an over and over or an inverting Connell type of suture and tied to its starting point. This completes the first anterior layer The second anterior layer is completed by the insertion of a series of interrupted horizontal seroserosal mattress sutures of fine silk (000)

E, F The first layer of the closure anteriorly consists of interrupted sutures of silk (000) which are inserted from the "inside out" to the "outside in," so that, when tied, the knots are on the inside of the lumen. The closure terminates in the midline using a figure of 8 mattress suture of silk (000). This method of closure is believed to lessen the hazard of leakage of the anastomosis by the avoidance of an angle" closure

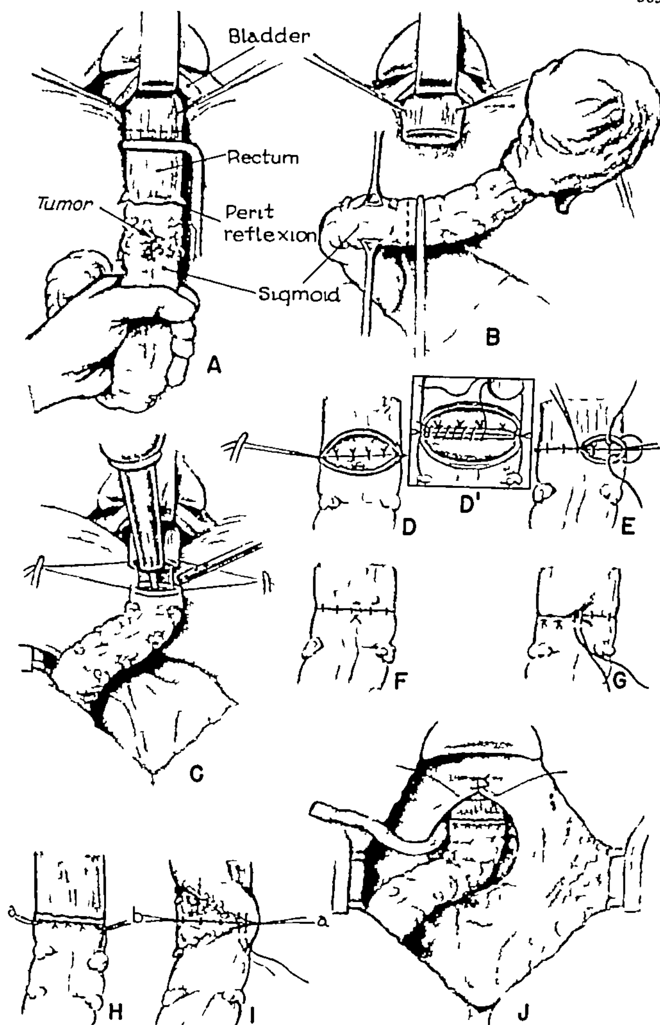
G H. The completion of the second layer anteriorly using interrupted mattress sutures of silk (000), is depicted.

I. Either lateral suture of the second layer anteriorly is left long to permit axial rotation of the bowel and to facilitate the insertion of the second layer of interrupted silk (000) mattress sutures posteriorly

J The anterior resection and the infraperitoneal anastomosis are completed. A drain is inserted into the hollow of the sacrum alongside of the anastomosis, and the reconstruction of the new pelvic floor is commenced In all infraperitoneal anastomoses between serosal and aserosal segments of the large bowel a complementary transverse colon colostomy is routinely performed.

DISCUSSION—DR MICHAEL R. DEDDISH. This operation has essentially supplanted the Miles type of resection where it is possible to obtain 6 cm of normal rectal wall below a carcinoma This measurement is determined only upon completion of the surgeon's dissection within the pelvic cavity and should be of the same extensive scope as described for the abdominal phase of the abdominoperineal resection. In the markedly obese patient, or where a very small male pelvis is encountered, this operation may not be feasible

In my experience the use of 0 chromic catgut suture material to effect the anastomosis is preferred. The use of silk sutures has made postoperative evaluations difficult and in some instances has resulted in stricture at the anastomosis. Infection may be present about a silk suture for many months, and it is most difficult to determine whether one is dealing with an abscess or residual disease at the anastomosis. Reperitonealization is not necessary and the use of a suprapubic drain brought out through the lower angle of the abdominal wound is used routinely A complementary transverse colostomy should be used where there is any question about the security of the anastomosis and especially in elderly patients


Bladder
Rectum
Tumor
Perit reflexion
Sigmoid
A
B
C
D
D'
E
F
G
a
b
a
H
I
J

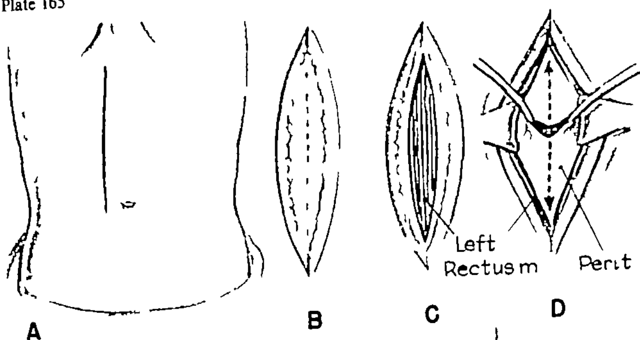
ONE STAGE COMBINED ABDOMINOPERINEAL RESECTION OF THE RECTUM (MILES)

A, B C, D E. The peritoneal cavity is entered through a left paramedian longitudinal muscle splitting incision which extends from the symphysis to a level just above the umbilicus The fibers of the rectus muscle are separated along the line of junction of the inner and middle thirds

F The patient is placed in the Trendelenburg position, and with the aid of moist gauze protective pads or preferably a large sheet or rubber tissue dam, the small bowel is displaced upward out of the operative field. Not infrequently a low attachment of the terminal ileum to the posterior parietal peritoneum is present and will require scissor dissection for its mobilization. In this dissection one should be careful to avoid injury to the subjacent right ureter

G The sigmoid colon is manually retracted toward the midline by the first assistant, and its mobilization laterally is commenced by scissor dissection along the fascia fusion layer of Toldt ("white line") down to the rectovesical or recto-uterine fossa.

Plate 165



E

F

Bladder

White line
fascia fusion
layer of Toldt

Sigmoid
colon

G

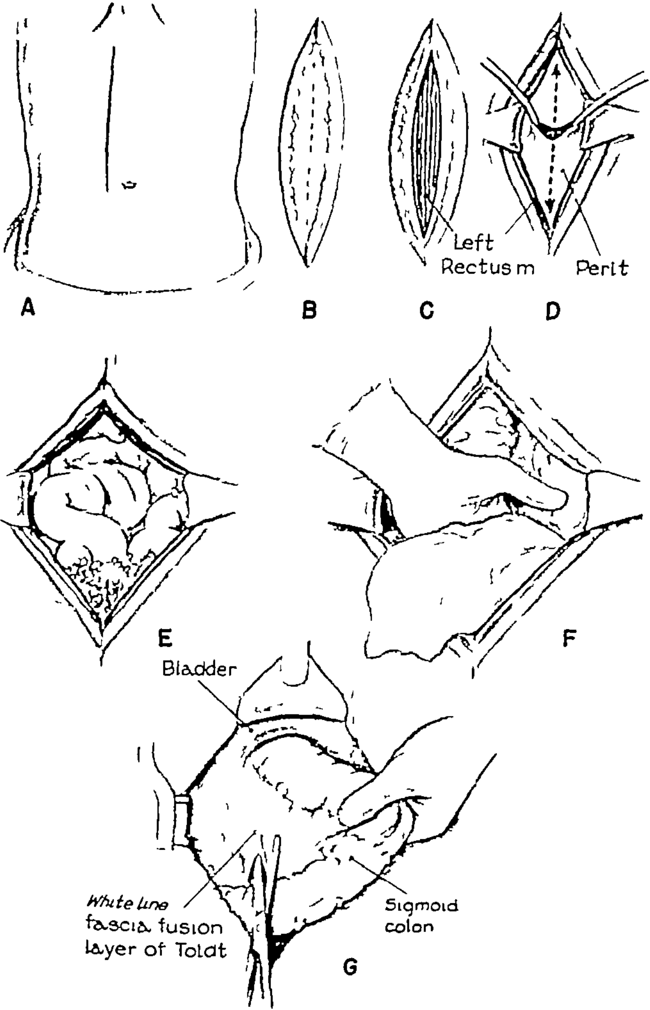
ONE STAGE COMBINED ABDOMINOPERINEAL RESECTION OF THE RECTUM (MILES)

A B C D E. The peritoneal cavity is entered through a left paramedian longitudinal muscle splitting incision which extends from the symphysis to a level just above the umbilicus. The fibers of the rectus muscle are separated along the line of junction of the inner and middle thirds.

F. The patient is placed in the Trendelenburg position, and with the aid of moist gauze protective pads or preferably a large sheet of rubber tissue dam, the small bowel is displaced upward out of the operative field.

Not infrequently a low attachment of the terminal ileum to the posterior parietal peritoneum is present and will require scissor dissection for its mobilization. In this dissection one should be careful to avoid injury to the subjacent right ureter.

G. The sigmoid colon is manually retracted toward the midline by the first assistant, and its mobilization laterally is commenced by scissor dissection along the fascia fusion layer of Toldt ("white line") down to the rectovesical or recto-uterine fossa.

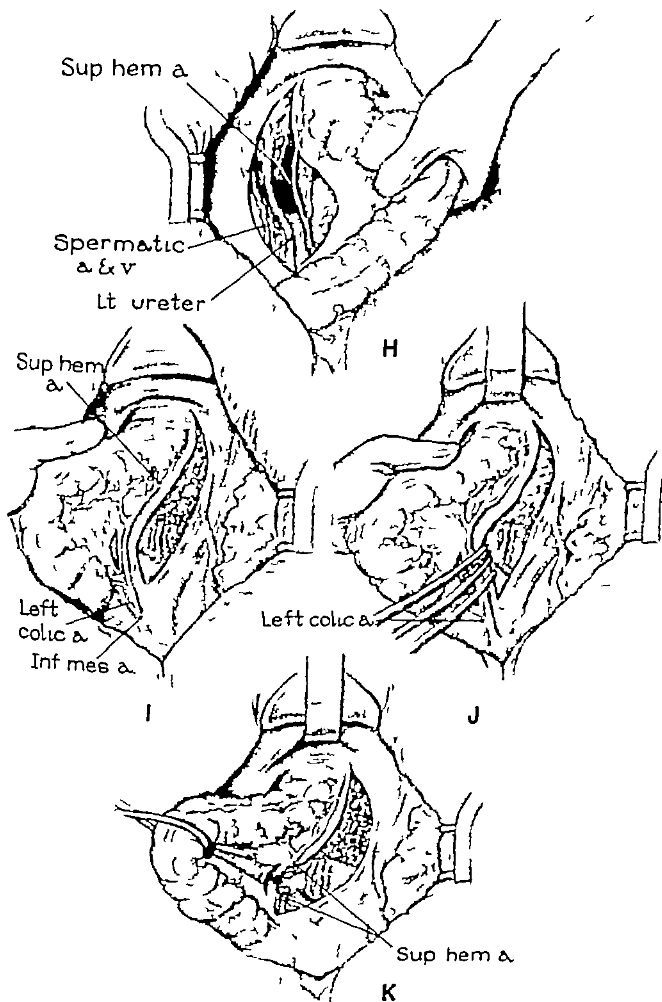

Left
Rectus m
Perit
A
B
C
D
E
F
Bladder
White line
fascia fusion
layer of Toldt
Sigmoid
colon
G

H. The mobilization of the sigmoid colon laterally is completed, and the three main anatomic landmarks are identified. These are the spermatic (or ovarian) vessels the left ureter and the superior hemorrhoidal artery

I. The sigmoid colon is retracted to the left, and the peritoneum at the base of the mesosigmoid is incised This incision extends from the level of the origin of the left colic artery downward to the rectovesical or recto-uterine fossa and terminates opposite the incision on the lateral side An opening through a relatively avascular segment of the mesosigmoid for the insertion of clamps is made adjacent to the superior hemorrhoidal vessels just below the bifurcation of the aorta

J The location of the superior hemorrhoidal artery in the base of the mesosigmoid is determined by visualization and/or palpation. Through the openings previously made in the mesosigmoid, the artery and its accompanying veins are triply clamped and severed between the two distal clamps. This is the site of election for severance of the vessels in the classic one stage abdominoperineal resection originally described by Miles. However in recent years, the "curative" operation has been extended to include not only ligation and division of the inferior mesenteric artery but also the mobilization and elevation of the duodenum and the head of the pancreas and the skeletonization of the aorta and vena cava by dissection of the lymphatic tissues from the level of the left renal vein downward into the pelvis along the iliac vessels The technic for this procedure which is advocated in all "curative" operations performed for cancer of the rectum, rectosigmoid, and left side of the colon is shown in the illustrations depicting the technic for Radical Left Hemicolectomy

K. The colon is encircled by a traction tape of rubber tissue at the site of election for subsequent transection. From this site an incision is made through the serosal layer of the mesosigmoid as a direction line for its severance and extends to the level of the division of the superior hemorrhoidal vessel.


Sup hem a
Spermatic a & v
Lt ureter
H
Sup hem a
Left colic a
Inf mes a
I
Left colic a
J
Sup hem a
K

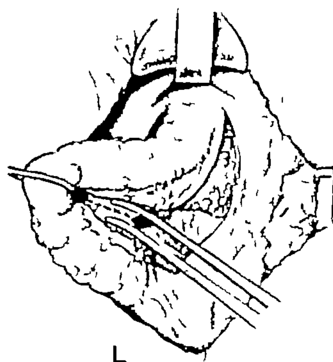
L. The mesosigmoid is serially clamped and severed as indicated in dotted outline Hemostasis is obtained with suture ligatures of 000 silk.

M By scissor dissection an opening is made in the fatty areolar tissue of the retrorectal and presacral space.

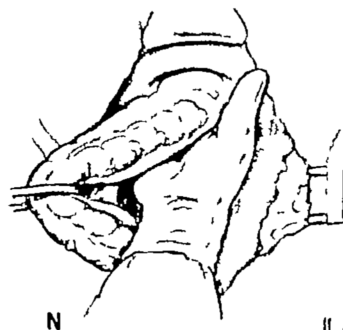
N Traction is maintained upward on the sigmoid colon, and by manual dissection in the presacral space the rectosigmoid and rectum are freed from the hollow of the sacrum downward to the level of the tip of the coccyx.

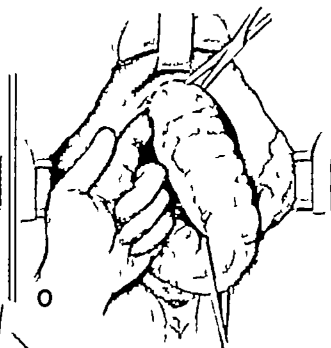
O A warm, moist gauze pad is placed in the hollow of the sacrum, and with traction on the sigmoid colon maintained, the lateral peritoneal incisions are united by division of the rectovesical or recto-uterine layer of peritoneum anteriorly This is facilitated by preliminary digital dissection beneath the peritoneal floor as demonstrated.

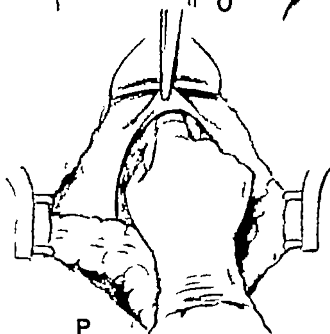
P A clamp for traction is placed on the distal cut margin of the rectovesical layer of peritoneum, and by digital dissection the avascular areolar tissue space posterior to the rectovesical fascia (Denonvilliers') is entered. The dissection of this space is continued down to the level of the tip of the prostate or the cervix uteri. Care should be taken to enter the proper plane of cleavage otherwise troublesome bleeding may occur


L


M


N


O

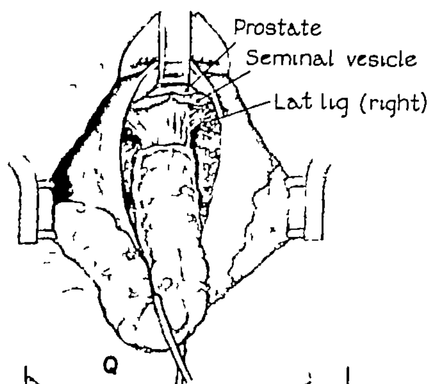

P

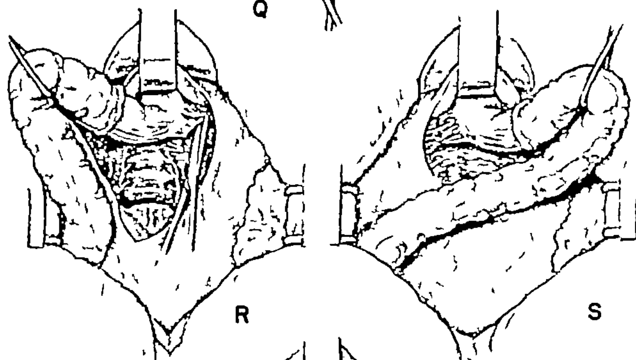
Q. The dissection is completed anteriorly and the prostate gland, seminal vesicles, and portions of the lateral ligaments are visible.

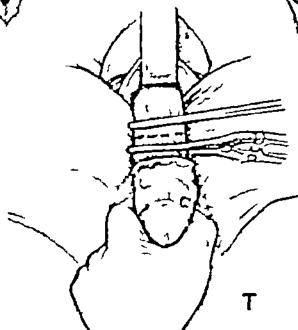
R. The colon is retracted laterally to the left, and the severance of the taut right lateral ligament with long scissors is commenced. In this dissection ligation of the middle hemorrhoidal artery contained within the lateral ligament is seldom required.

S. The sigmoid colon is retracted toward the midline, and the left lateral ligament is similarly severed as depicted by the dotted line.

T. After the severance of the lateral ligaments the dissection of the rectum is continued down to the level of the levator floor and the distal bowel segment is divided between clamps.


Prostate
Seminal vesicle
Lat lig (right)
Q


R
S


T

U U U The proximal end of the rectum is occluded with a ligature of heavy silk (No 1) and coverd with a small sheet of rubber tissue

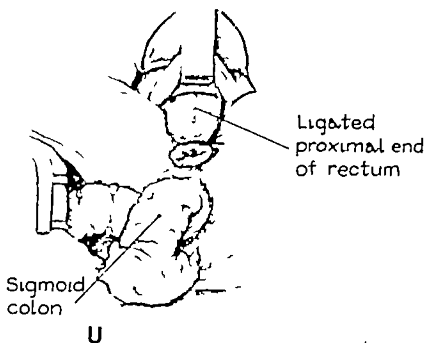
V V To facilitate both the displacement of the distal segment of the bowel into the hollow of the sacrum and the reperitonization of the pelvic floor a low division of the bowel and resection of the redundant segment ("nuisance loop") may be required. However this should be avoided whenever possible because of the potential danger of transecting lymphatic vessels that may be either grossly or microscopically infiltrated by cancer cells

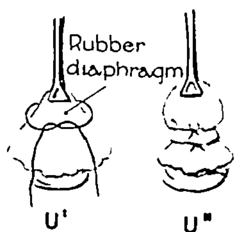
DISCUSSION—DR. MICHAEL R. DEDDISH. This operation is indicated for cancer of the rectum at the level of the levator muscles, or just above and for most cancers of the anal canal.

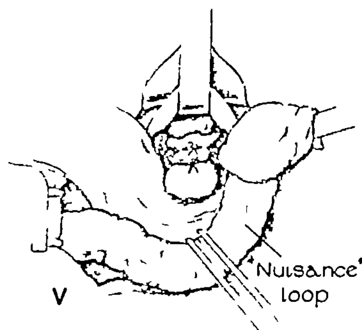
A left paramedian longitudinal muscle-retracting lower abdominal incision seems preferable to the muscle-splitting incision as illustrated This incision leaves the left rectus muscle intact with its blood and nerve supply and gives better support to a midline colostomy Predisposition to a ventral or paracolostomy hernia should be avoided when possible. Such a complication usually interferes with the proper function of the colostomy

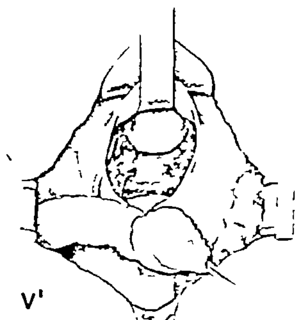
The medial and lateral leaves of the sigmoid mesentery should be developed with a wide margin about the tumor as might be indicated by the extent of visceral peritoneal involvement. Miles originally described incising the peritoneum at the pelvic brim. Too frequently cancer-invaded peritoneum is left in the pelvis in the effort to allow adequate peritoneum with which to construct a new pelvic floor

Extending the Miles type of resection to include the ligation of the inferior mesenteric artery at the aorta has quite naturally led to the dissection of the lymphatic-bearing tissues about the great vessels of the lower abdomen. Better mobilization of the distal


Ligated proximal end of rectum
Sigmoid colon
U


Rubber diaphragm
U'
U"


'Nuisance' loop
V


V'

W. Sagittal section to show the completed abdominal phase of the operation. The reperitonization of the pelvic floor, the "turn in" of the distal cut end of the sigmoid and proximal segment of the rectum into the hollow of the sacrum, and the location of the tumor are demonstrable.

X. The reperitonization of the pelvic floor when viewed through the abdominal incision.

Y. The operation table is levelled, and the closure of the abdominal incision is commenced. The small bowel is replaced into the pelvis and the proximal cut end of the sigmoid colon is exteriorized through the abdominal incision at a site where it is without either undue angulation or tension. This is usually at the junction of the upper and middle one third of the incision. To prevent herniation of the small bowel the sigmoid colon is anchored to the lateral parietal peritoneum with interrupted sutures of fine (000) silk. However, many surgeons of experience do not think that this is necessary. In the closure of the incision the modification of the Jones technic, using interrupted sutures of silk (00) rather than stainless steel wire is preferred. In this closure the sutures are inserted through the fascia, muscle, and peritoneal layers on one side, and through the peritoneal muscle and fascia layers on the other. The suture is then crossed over the incision and reinserted through the fascia layers only on either side.

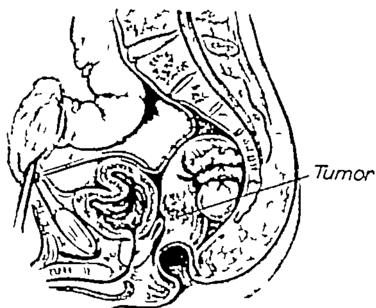
Z. The completed modified "Jones closure" of the fascia, muscle, and peritoneal layers is demonstrated.

Z. The closure of the skin layer using interrupted sutures of silk (000) is completed. No sutures are used to anchor the exteriorized segment of the sigmoid colon to any part of the abdominal wall during the wound closure. The clamp on the colon is removed within 12 hours, and following the separation of the agglutinated ends of the bowel, its lumen is digitally explored. If desired, the clamp on the colon may be removed immediately upon the completion of the wound closure and the cut end of the bowel sutured to the skin margins either at the site of its exteriorization in the incision or to the margins of a lateral "stab" wound. The technic for its performance is the same as illustrated for the establishment of an ileostomy stoma as advocated by Brooke and depicted in Plate 143 of the illustrations for Ileostomy and Subtotal Colectomy.

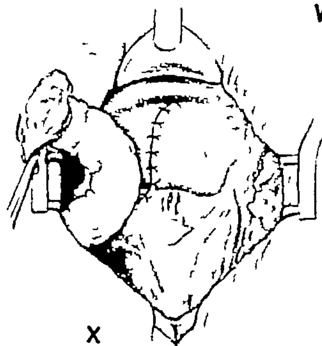
DISCUSSION—DR. DEDDISH (cont.)

descending colon is so effected. The inferior mesenteric vein and the sigmoid branches of the inferior mesenteric artery should be isolated and ligated individually near their junction with the marginal vessel. Conservatism in our treatment of this portion of the mesentery has resulted in leaving residual disease.

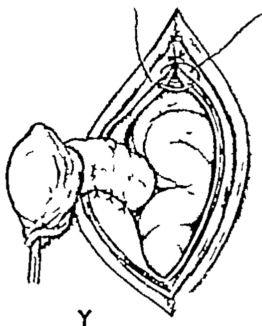
Definite emphasis might be made on the extent of the abdominal phase of the pelvic dissection. This should include a clean dissection of the node bearing tissues about the iliac and hypogastric vessels. The pelvic fascia with its extensions should be excised at the most lateral attachments and should include the supralevator fascia. This latter step greatly facilitates the perineal resection of the rectum and should eliminate the possibility of rupturing the operative specimen from below and the resultant "seeding" of tumor within the pelvic cavity. A comment on the extent of the abdominal phase of this operation would not be complete without stating that any adjacent organs intimately associated with a rectal tumor, including the omentum and ovaries, should also be resected. It has been my experience that closure of the abdominal incision by the Jones technic, using No. 32 stainless steel wire, has resulted in much fewer wound infections and foreign body reactions.



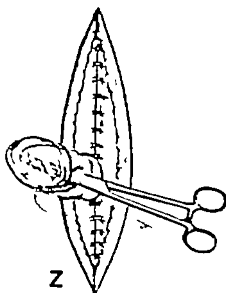
W



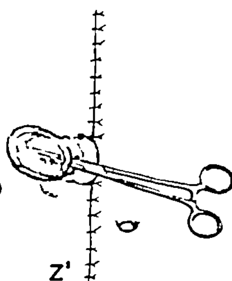
X



Y



Z



Z'

A. The patient is placed in the left lateral prone (Sims') position with the left buttock over the edge of the operation table. If preferred, the lithotomy position may be used. A purse-string suture of heavy silk (No 1) is inserted to occlude the anal orifice, and the elliptical incision employed is outlined. For clarity the draping of the operating field is eliminated.

B C, D The purse string suture is tied, and first the lowermost and then the uppermost portion of the perianal elliptical incision is deepened into the subcutaneous fatty tissue plane. The severed branches of the external hemorrhoidal artery are clamped and ligated with fine silk (0000)

E. The tip of the coccyx is identified by palpation and the anococcygeal raphe is divided transversely to expose the fascia propria. This is similarly cut transversely and the presacral space is entered.

F The left index finger is used to tent the levator sling above, and the muscle is widely excised out to the ischial tuberosity

DISCUSSION—DR. DEDDISH (cont.)

At the perineal resection of the rectum, the distance of the skin incision from the anal margin is determined by the proximity of the tumor to the anal canal. In other words, for a low-lying tumor there should be wide excision of the perineal skin, removal of the ischiorectal space fat, and transection of the levator ani muscles at their most lateral extent. Control of the pudendal vessels is best secured by suture ligatures. The use of plain catgut ligatures for the smaller vessels will eliminate many troublesome sinuses due to foreign body reaction. In patients whose work requires heavy manual labor a gauze pack in a rubber sheet or a size eight surgeon s glove is placed in the lower pelvic cavity This is secured by interrupted skin edge sutures and is kept in place until the patient has recovered from postoperative ileus and is on a full diet. After removal of the pack, the outlet of the pelvis fills with granulation tissue, dense scarring, and subsequent better support. In my experience, primary suture of the subcutaneous fat and skin has resulted in a greater incidence of perineal herniae There is also a psychologic advantage to the patient when the gluteal cleft is preserved.

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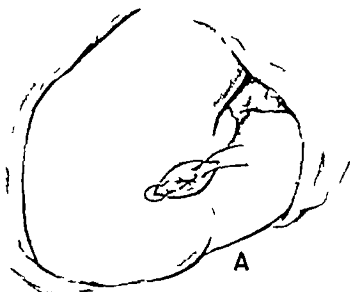
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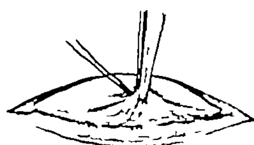
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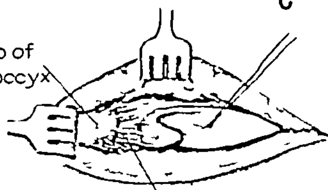
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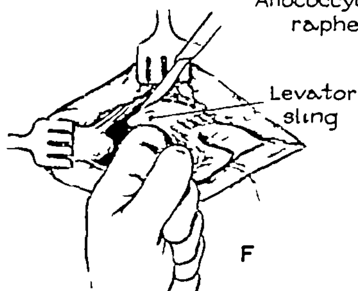

A


B


C


D


Tip of coccyx
Anococcygeal raphe
E


Levator sling
F

G H. The levator sling below is similarly widely excised, and the rubber covered distal cut end of the rectosigmoid segment is easily withdrawn from the hollow of the sacrum.

I. The division of the levator muscles anteriorly is completed, and the cut margin of the central tendon of the perineum is demonstrable. Traction is maintained anteriorly and the rectum is separated by sharp dissection from the prostate gland and the adjacent tissue. In this dissection one must be careful to avoid injury to the underlying membranous portion of the urethra.

J, K. The perineal portion of the operation is completed, and a rubber tissue cigarette drain is inserted to the level of the base of the prostate gland. A drain is preferred to the use of a diaphragm pack because of the more rapid and more satisfactory wound healing that is obtained.

L, M The closure of the perineal wound is completed using both simple interrupted and vertical "on-end" mattress sutures of silk (000) The application of a soft absorbent perineal dressing and T binder support completes the operation The drain is removed routinely on the fourth day postoperatively Daily thereafter a soft rubber catheter (12 F) is inserted through the drain site and the depths of the wound are gently irrigated with a solution containing equal parts of hydrogen peroxide and isotonic saline The patient is allowed out of bed on the fourth to sixth day postoperatively and the skin sutures are removed on the eighth to tenth postoperative day

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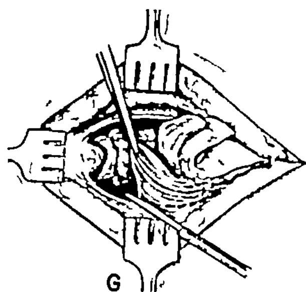
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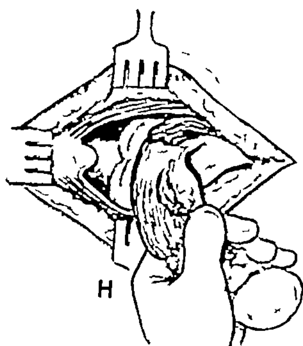
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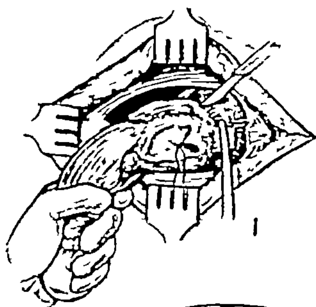
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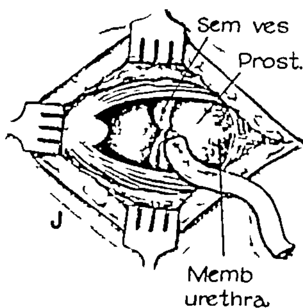
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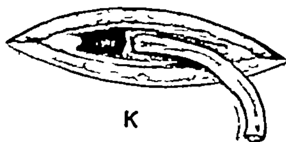
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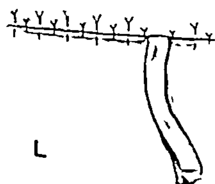

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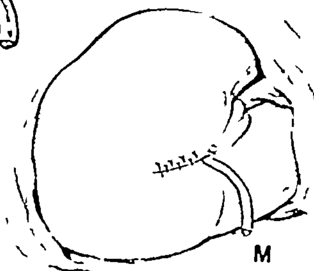

H


I


Sem ves
Prost.
J
Memb
urethra


K


L


M

A. The patient is placed in the supine position with the buttocks overhanging the edge of the operation table and the hips and knees maintained in a flexed position by suitable strapping. In this position the perineum and the lower abdomen are accessible surgically without moving the patient. The left rectus paramedian muscle retracting (lateral) incision is indicated by the solid black line.

B. The peritoneal cavity is entered, and the dilated, redundant loop of sigmoid colon is exteriorized. The narrow segment of the colon distally in comparison with the dilated segment proximally is visible.

C, D The mobilization of the sigmoid colon is begun by severance of the lateral parietal peritoneal reflection using scissor dissection (C). When this is completed, the three anatomic landmarks routinely demonstrated are the left ureter, the ovarian or spermatic vessels, and the superior hemorrhoidal artery (D).

E, F The superior hemorrhoidal vessels are triply clamped and severed (dotted line) between the two most distal clamps (E). The two most proximal clamps are replaced by a ligature and a suture ligature respectively of 00 silk. Subsequently the mesentery of the sigmoid colon and its contained vessels are serially clamped, severed, and ligated, and the freed mesenteric border of the bowel wall is encircled by a tape of rubber tissue (F). The presacral areolar tissue space is entered by scissor dissection (F) prior to the mobilization of the rectum from the hollow of the sacrum.

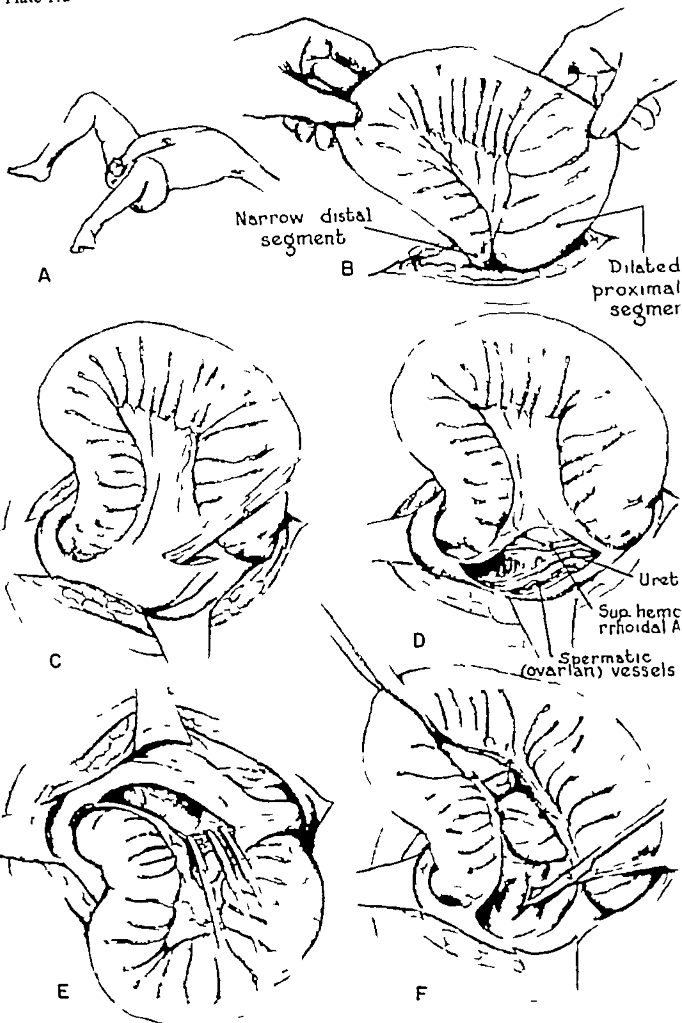
DISCUSSION—DR. ROBERT B. HIATT The positioning of the patient for a pull through procedure is most easily done by lowering the foot of the operation table and placing the buttocks near the edge with the legs placed on arm boards and separated as far as possible. This allows easy access to the anus when the time comes to intussuscept the rectum and lower sigmoid through the anus.

While the incision depicted (Plate 173, A) is adequate for this procedure, I prefer the lower transverse incision with a cephalad curve above the left anterior superior spine. I find it easier to detach the splenic flexure through this incision if the aganglionic segment is unusually long, and the cosmetic result is much better.

If there is any doubt about the length of the aganglionic segment, one should take a button of muscularis from the anterior taenia for frozen section. It is not necessary to enter the lumen since one is primarily interested in the ganglion cells between the two muscle coats only. In freeing the rectum from its surrounding structure, the surgeon should keep in mind the importance of preserving the autonomic enervation of the bladder and seminal vesicles. To do this, the hypogastric plexus must be avoided by dividing the superior hemorrhoidal vessels as near to the rectum as possible. The presacral space can then be entered in the midline and the rectum separated from the sacrum, coccyx, and posterior levators. The lateral ligaments of the rectum (Plate 174, J) can then be stripped anteriorly to their attachments in each anterolateral angle of the rectum and subsequently divided between clamps adjacent to the rectum itself without compromising the sympathetic trunks as they swing from the hypogastric plexus around the lateral pelvic wall to enervate the bladder and seminal vesicles.

Plate 174, I, is most misleading because, in the male, this phase of the rectal dissection is of utmost importance and cannot be properly done by blunt dissection until Denonvilliers's fascia is identified and separated from the rectum by sharp dissection. Once this is done and the bare muscularis of the anterior wall of the lower rectum visualized, the dissection can be easily completed to the anal level by blunt finger dissection.

If the surgeon uses the proper sequence in the rectal dissection, it is possible to accomplish all of the maneuvers under direct vision with controlled hemostasis. In principle it simply means performing all of the posterior maneuvers before attempting to dissect anything anteriorly. I will outline this sequence as follows: (1) Divide the superior hemorrhoidal vessels away from the hypogastric plexus just before the


A
Narrow distal segment
B
Dilated proximal segmer
C
D
Uret
Sup. hemc rrhoidal A
Spermatic (ovarian) vessels
E
F

G. By blunt digital dissection in the presacral space, the rectum is mobilized from the hollow of the sacrum down to the tip of the coccyx.

H. The rectovesical fold of peritoneum is freed by blunt digital dissection and severed with scissors as depicted.

I. The lower cut margin of the rectovesical fold of peritoneum is retracted downward in a clamp (Babcock) and blunt digital dissection in the rectovesical space behind Denonvilliers' fascia is performed. In this dissection it is most important to enter the proper tissue plane to avoid injury to the prostate or seminal vesicles, as well as troublesome bleeding.

J. The right lateral ligament is being cut by scissor dissection. The severance of the left lateral ligament is indicated by the dotted line. In this dissection the middle hemorrhoidal vessels are severed, and if bleeding is excessive, the severed ends are clamped and ligated. Generally no untoward bleeding is observed.

K. The lateral ligaments are cut, and the mobilization of the rectum down to the levator floor is completed.

L. The anterior wall of the distal sigmoid colon is indented by the index finger and the inverted wall is grasped in a ring clamp which is inserted through the rectum. By a combination of traction from below and digital inversion from above the sigmoid colon is telescoped into the lower sigmoid segment and protruded inside-out through the anus. This is the technic advocated by Hiatt. If preferred, the recommendation of Swenson—transection of the sigmoid colon distally and closure of the proximal transected end—may be followed. The cut margins of the distal transected end are secured in two guy sutures of silk (00) which are withdrawn through the anus to turn the lower segment inside-out. The closed proximal transected end is then withdrawn through the anus with the distal segment encircling it as an everted sleeves. The proximal transected end is then opened, and a two-layer anastomosis between the everted (inside-out) lower segment and the pull-through proximal segment is performed.

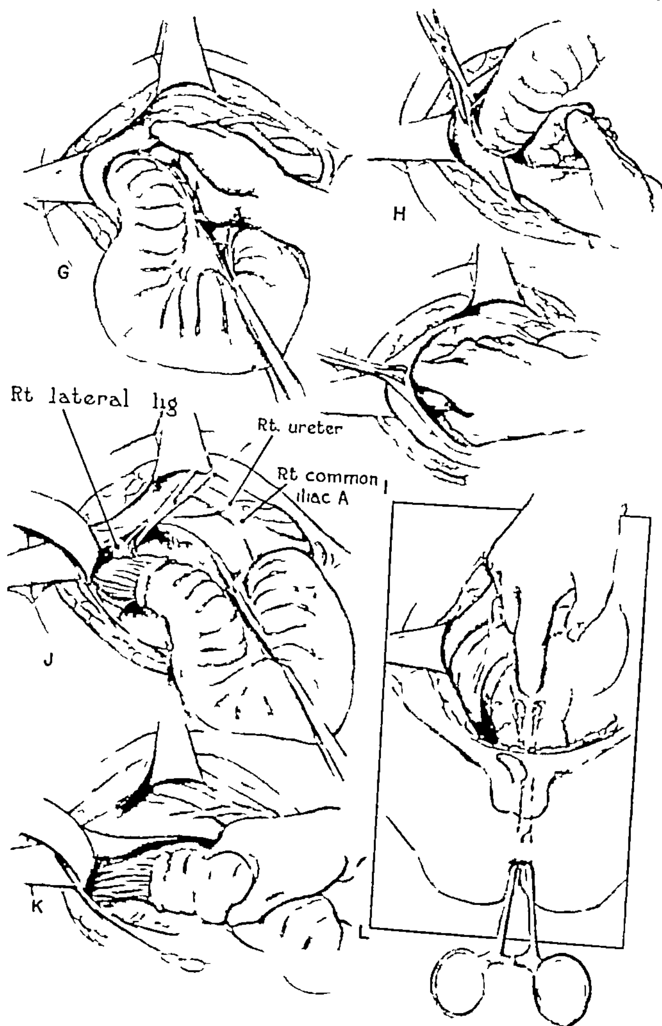
Discussion—Dr. Hiatt (cont.)

artery branches. (2) Enter the presacral space in the midline and separate the rectum from the sacrum, coccyx, and posterior perineum. To do this, it is usually necessary to divide the posterior attachments of the lateral ligaments of the rectum. (3) Strip the lateral ligaments of the rectum anteriorly to their ultimate attachments to the rectum in the anterolateral quadrants. (4) Divide these ligaments and the contained middle hemorrhoidal arteries between clamps close to the rectum. (5) Carefully separate Denonvillier's fascia from the anterior wall of the rectum by sharp dissection, and complete the distal dissection to the anus under direct vision.

Before everting the rectum through the anus, the distal dissection should be checked by having an assistant gently place his finger in the anal canal from below. The operating surgeon should then be able, from within the pelvis, to palpate the assistant's finger with ease around the entire circumference of the anorectal junction.

When the eversion of the rectum is being done by the assistant, the surgeon must be certain that the area of the sigmoid he has chosen to anastomose to the anus reaches the anal level accurately and without torsion. This is most easily accomplished by placing a stay suture in the anterior taenia at the point of election for anastomosis and holding the free end in one hand while checking its descent with the other hand until it lies accurately in the anterior anus. This can be checked by the assistant's palpating through the anterior portion of the everted anus.

It must be remembered that the levator ani muscle has its attachments to the external sphincter and not to the rectum. The dissection should be carried to the sphincter level so that, when the rectum is everted through the anus, the anus itself should also be everted. For this reason the illustrations M, N, O, P and Q (Plate 175) are inaccurate. The circumferential incision in the anorectal junction should be made in the columnar epithelium of the everted anus within 0.5 to 1 cm. of the stratified squamous epithelium of the anus. It is an inadequate resection to leave any of the distal rectum in place. The technic as portrayed here is for congenital megacolon of the classic variety in which the aganglionic segment extends proximally to a point between the midrectum and midsigmoid. The megarectum (short aganglionic segment type) and the extremely long aganglionic segment, which extends to any point in the colon proximal to the sigmoid, require slightly altered technics for proper handling.


G
H
Rt lateral lig
Rt. ureter
Rt common iliac A
I
J
K
L

G. By blunt digital dissection in the presacral space the rectum is mobilized from the hollow of the sacrum down to the tip of the coccyx.

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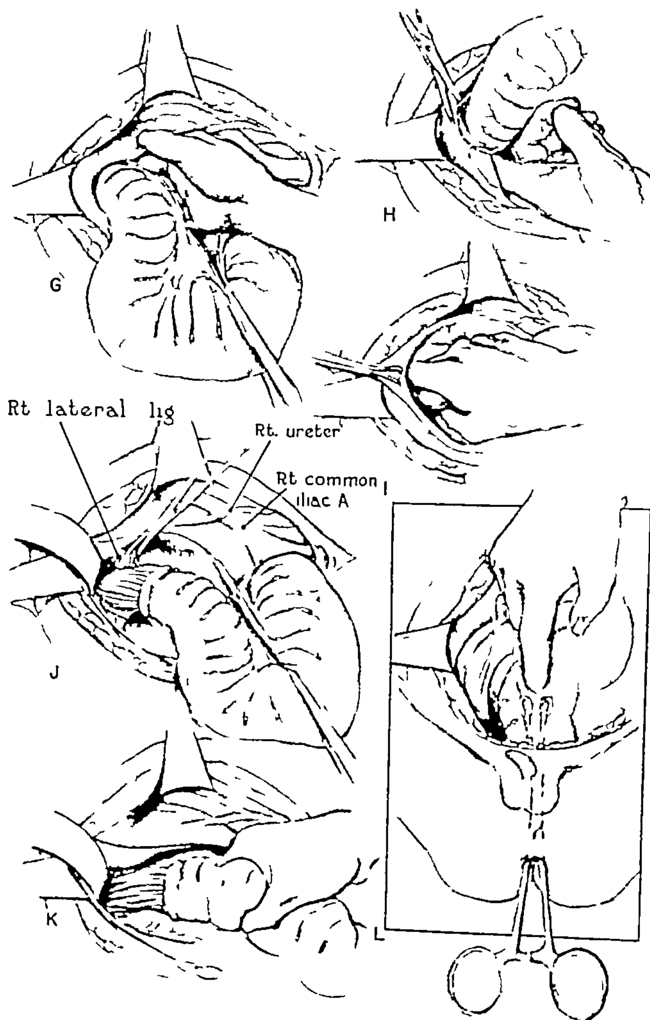
DISCUSSION—DR. HIATT (cont.)

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G
H
Rt lateral lig
Rt. ureter
Rt common
iliac A
I
J
K
L

M. Through guy sutures of silk (000), traction is maintained on the protruded segment of the colon, and a circular incision is made through the mucosa, muscularis, and serosa of the outer bowel wall.

N. This illustration shows the first or seroserosal layer of silk sutures (000) being inserted.

O The circular incision about the whole of the circumference of the outer wall of the telescoped segment of bowel and the first or seroserosal anastomotic layer are completed.

P The distal cut margin of the outer bowel wall is pulled downward, and the length of the telescoped segment of bowel to be amputated is visible An incision through the whole of the thickness of the "inner" bowel segment, serosa, muscularis, and mucosa is being made by scalpel dissection.

Q The interrupted sutures (000 silk) which form the second layer of the anastomosis are inserted through the whole thickness of each segment of the bowel wall.

R. The insertion of two of the four quadrants of sutures (000 silk) which form the second layer of the anastomosis is completed, and the remaining attachment of the protruded bowel segment is being severed by scissor dissection.

S. The remaining two quadrants of sutures are inserted to complete the second layer of the anastomosis The view is magnified for clarity

T, U By digital manipulation (T), the anastomotic ring is inverted into the anal canal to complete the operation. The appearance of the anus following this maneuver is normal (U).

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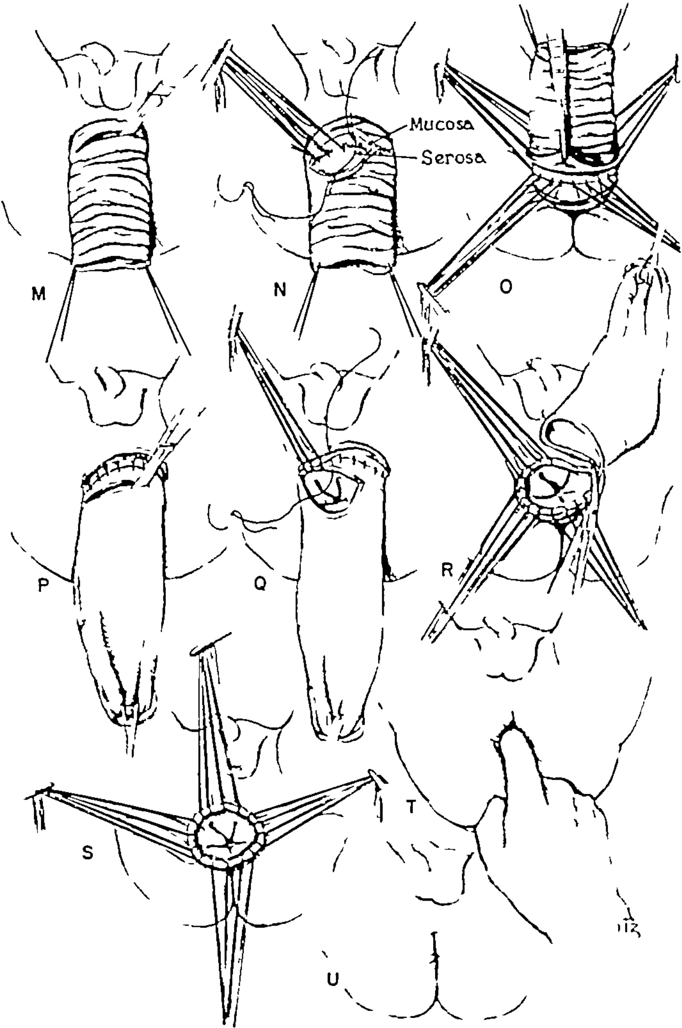
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Mucosa
Serosa
M
N
O
P
Q
R
S
T
U

M. Through guy sutures of silk (000) traction is maintained on the protruded segment of the colon, and a circular incision is made through the mucosa, muscularis, and serosa of the outer bowel wall.

N This illustration shows the first or seroserosal layer of silk sutures (000) being inserted.

O The circular incision about the whole of the circumference of the outer wall of the telescoped segment of bowel and the first or seroserosal anastomotic layer are completed.

P The distal cut margin of the outer bowel wall is pulled downward, and the length of the telescoped segment of bowel to be amputated is visible An incision through the whole of the thickness of the "inner" bowel segment, serosa, muscularis, and mucosa is being made by scalpel dissection.

Q The interrupted sutures (000 silk) which form the second layer of the anastomosis are inserted through the whole thickness of each segment of the bowel wall.

R. The insertion of two of the four quadrants of sutures (000 silk) which form the second layer of the anastomosis is completed, and the remaining attachment of the protruded bowel segment is being severed by scissor dissection.

S. The remaining two quadrants of sutures are inserted to complete the second layer of the anastomosis. The view is magnified for clarity

T U By digital manipulation (T), the anastomotic ring is inverted into the anal canal to complete the operation. The appearance of the anus following this maneuver is normal (U).

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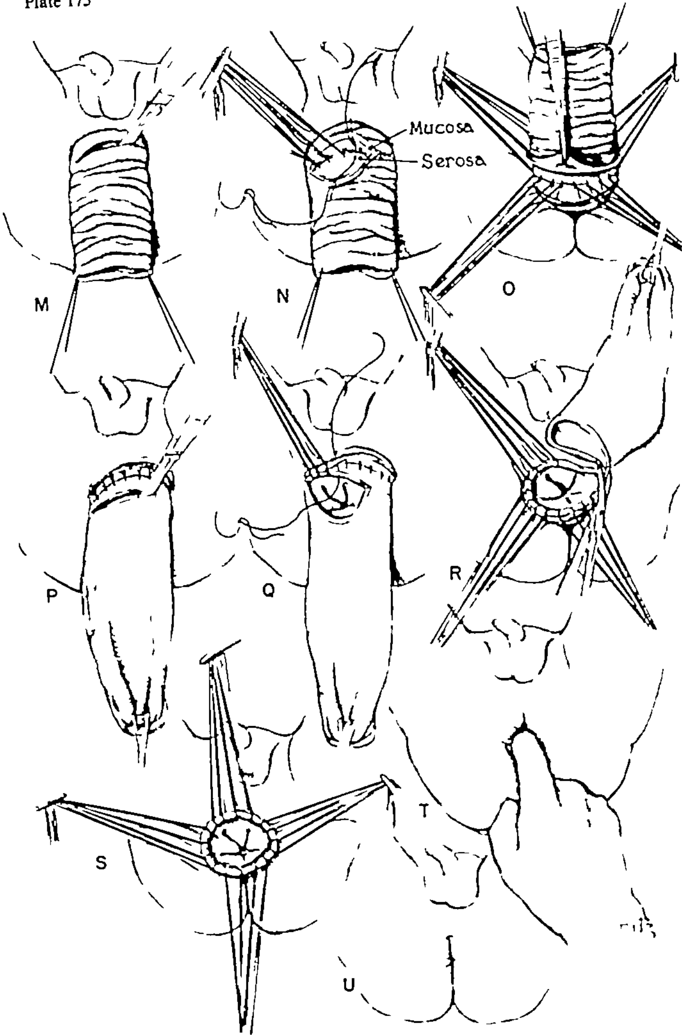
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Plate 175



M. Through guy sutures of silk (000), traction is maintained on the protruded segment of the colon, and a circular incision is made through the mucosa, muscularis, and serosa of the outer bowel wall.

N This illustration shows the first or sero-serosal layer of silk sutures (000) being inserted.

O The circular incision about the whole of the circumference of the outer wall of the telescoped segment of bowel and the first or seroserosal anastomotic layer are completed.

P The distal cut margin of the outer bowel wall is pulled downward, and the length of the telescoped segment of bowel to be amputated is visible. An incision through the whole of the thickness of the "inner" bowel segment, serosa, muscularis, and mucosa is being made by scalpel dissection.

Q The interrupted sutures (000 silk) which form the second layer of the anastomosis are inserted through the whole thickness of each segment of the bowel wall.

R. The insertion of two of the four quadrants of sutures (000 silk) which form the second layer of the anastomosis is completed, and the remaining attachment of the protruded bowel segment is being severed by scissor dissection.

S. The remaining two quadrants of sutures are inserted to complete the second layer of the anastomosis The view is magnified for clarity

T, U By digital manipulation (T), the anastomotic ring is inverted into the anal canal to complete the operation. The appearance of the anus following this maneuver is normal (U).

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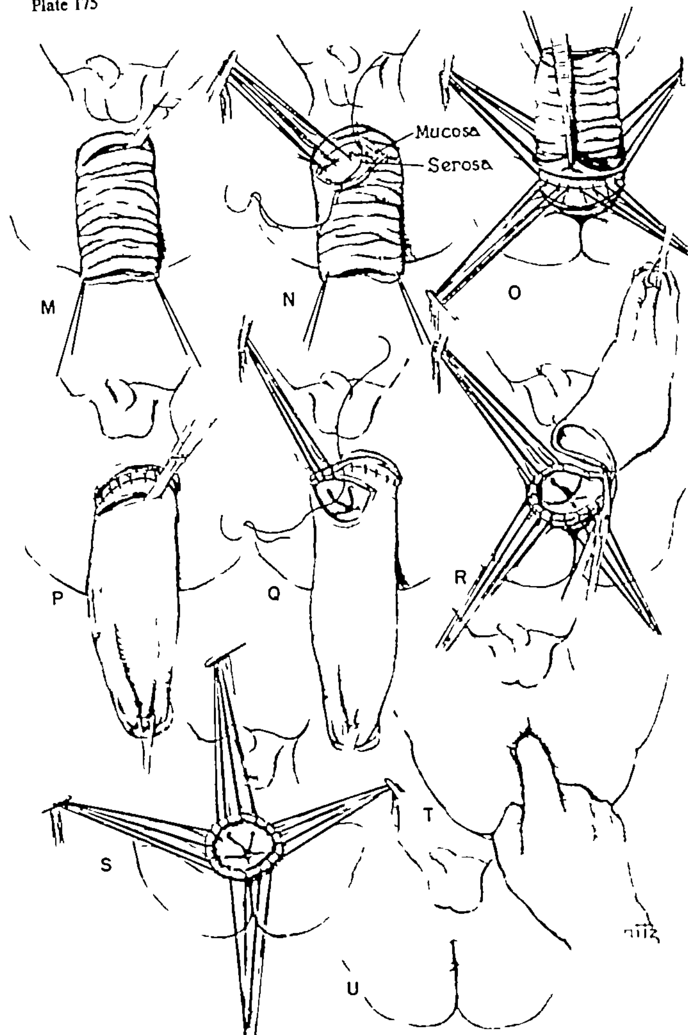
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Plate 175



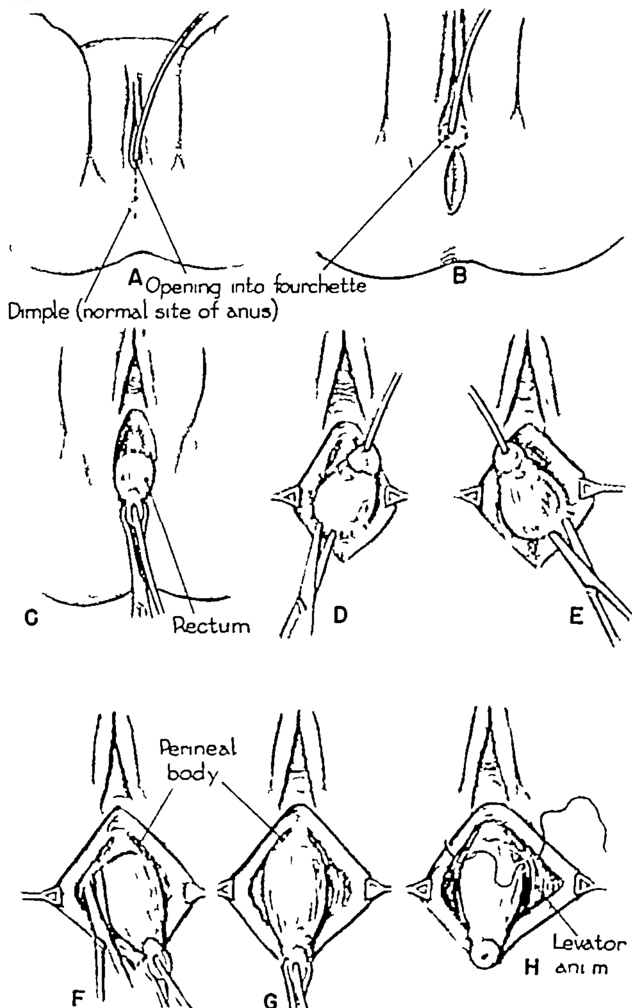
IMPERFORATE ANUS

A. A sound is inserted into the rectal lumen through the ectopic anal opening in the fourchette. The vertical incision extending posterior from the fourchette through the dimple indicative of the normal site of the anus is depicted by the dotted line. This incision bisects the sphincter ani musculature.

B. The vertical incision is partially completed into the underlying subcutaneous tissue, and the circumscribed incision about the ectopic anus in the fourchette is shown in dotted outline

C, D, E. Dissection is continued deeper into the underlying tissues, and the rectum is mobilized by scissor dissection.

F G H The mobilization of the rectum is completed, and its relation to the transected perineal body and to the margins of the levator ani muscles is shown. A suture (00 silk) is being inserted (H) to approximate the fibers of the levator ani muscles in front of the mobilized rectum.


A
Opening into fourchette
B
Dimple (normal site of anus)
C
Rectum
D
E
Perineal body
F
G
H
Levator ani m

I J K. A second suture (00 silk) is inserted in the levator ani muscles (I) and tied (J) to complete the approximation of these structures anterior to the rectum. The first of two sutures is inserted in the transected ends of the perineal body (J), which are approximated when the sutures are tied (K). The skin closure of the perineum is begun by the insertion of a suture of 000 silk (K)

L. The last perineal skin suture anterior and the first one posterior to the rectum include a "bite" of its muscle layer

M. The anchoring perineal skin sutures just inserted (L) are tied, and the site of transection of the rectum proximal to the contracted segment of the ectopic anal canal is indicated by the dotted line.

N The transection of the rectum is being completed by scissor dissection.

O. The cut margins of the rectum are approximated to the surrounding skin margins by four cardinal guy sutures of silk (000).

P Q The four cardinal guy sutures are tied, and the intervening approximation sutures are all first inserted (P) and then tied (Q) to complete the construction of the new anus.

R. By digital manipulation, the perianal suture line is inverted into the rectal canal, and the relation of the patulous anal opening to the other structures in the perineum is visible.

This patient, a white infant girl, delivered spontaneously at full term, was perfectly normal with the exception of the ectopic anal orifice within the fourchette. The operation as illustrated was performed the day after birth, and the postoperative convalescence was uneventful. The follow up period to date is 28 months. Except for occasional bouts of constipation, bowel function and control are completely satisfactory

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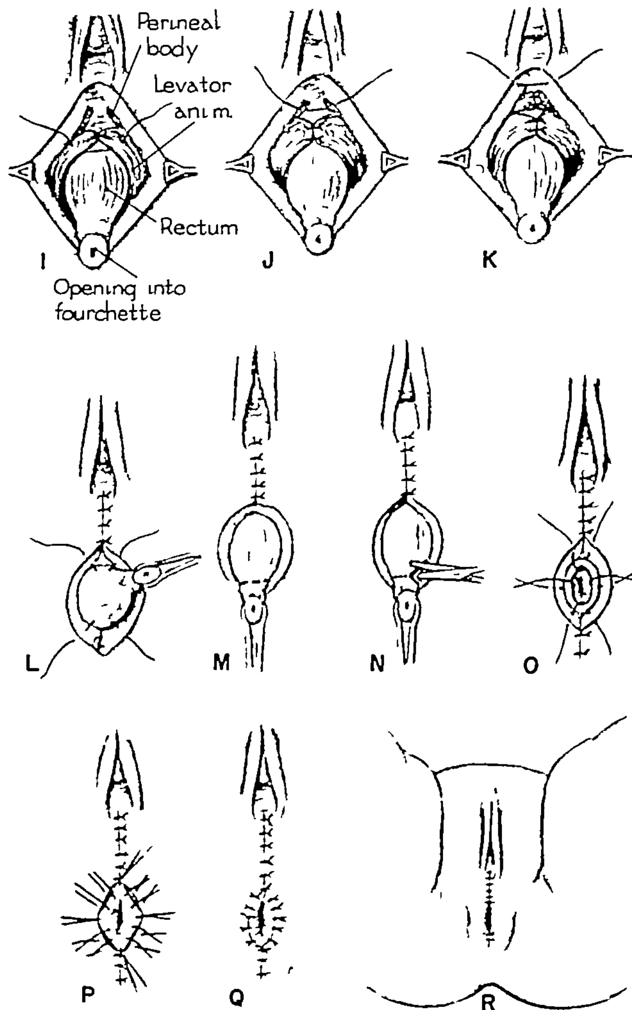
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Perineal body
Levator ani m.
Rectum
Opening into fourchette
I
J
K
L
M
N
O
P
Q
R

EXCISION OF FISSURE IN ANO

A, B. The patient is placed in the prone modified "jackknife" position (Buie), and the buttocks are separated by adhesive tapes. The "sentinel pile" (Brodie) that is visible (A) is shown in a close up view (B).

C. An anoscopic view within the anal canal shows the anatomic pathologic characteristics of a fissure in ano—(1) the "sentinel pile" of Brodie, (2) the fissure, (3) the hypertrophied anal papilla.

D The mucocutaneous junction of the anus is retracted by triangular (Pennington) clamps placed at equidistant points about the anal orifice.

E. A curved probe is inserted to show the depth of the sinus beneath the lower margin of the fissure and leading into the base of the "sentinel pile."

F The tip of the "sentinel pile" is grasped in a clamp and, with downward traction maintained, a wide excision of the fissure is begun.

G. Traction on the "sentinel pile" is then directed upward, and the incision is continued on either side of the fissure into the mucosa of the anal canal to include the site of the hypertrophied anal papilla.

H. The wide excision of the fissure is completed, and a partial severance of the superficial fibers of the subcutaneous external sphincter muscle is being performed.

I J Upon completion of the partial sphincterotomy (I), the operative area is inspected for bleeding, and a narrow strip of sterile gauze impregnated with petrolatum is inserted into the anal canal (J).

K. A sterile gauze dressing is applied and subsequently secured by the use of a T-binder

DISCUSSION—DR. CON AMORE V BURT It is rare that I do a simple excision of a fissure. Almost invariably in my experience, there are associated hemorrhoids or large crypts. It seems desirable to remove these along with the fissure. It is most important to remove any associated anal papillae and to excise the mucocutaneous line above the fissure. Usually there is an enlarged papilla above the fissure.

It is important to have an adequate drainage area in the skin of the verge, as shown in H. If the external wound heals before that of the anal canal, the fissure persists.

The old fibrous tissue at the base of the fissure should be carefully removed Usually this means excising the superficial surface of the underlying sphincter

It is only in the old recurrent fissure that I feel it is necessary to incise the sphincter I rarely do a sphincterotomy and when I do I make a much deeper cut into the sphincter than that shown in H and I The proper use of local anesthesia in oil generally leaves the sphincter relaxed. In older people there is sometimes, around the entire anal canal, a rather marked degree of fibrosis, which must be broken down during the anal dilatation. In these cases a sphincterotomy is particularly desirable.

Since the passing of hard stools is the cause of most fissures, proper instructions as to bowel hygiene is an important consideration postoperatively The use of zinc peroxide, local anesthesia in oil, antibiotics, mineral oil, and so forth is the same as prescribed for hemorrhoidectomy

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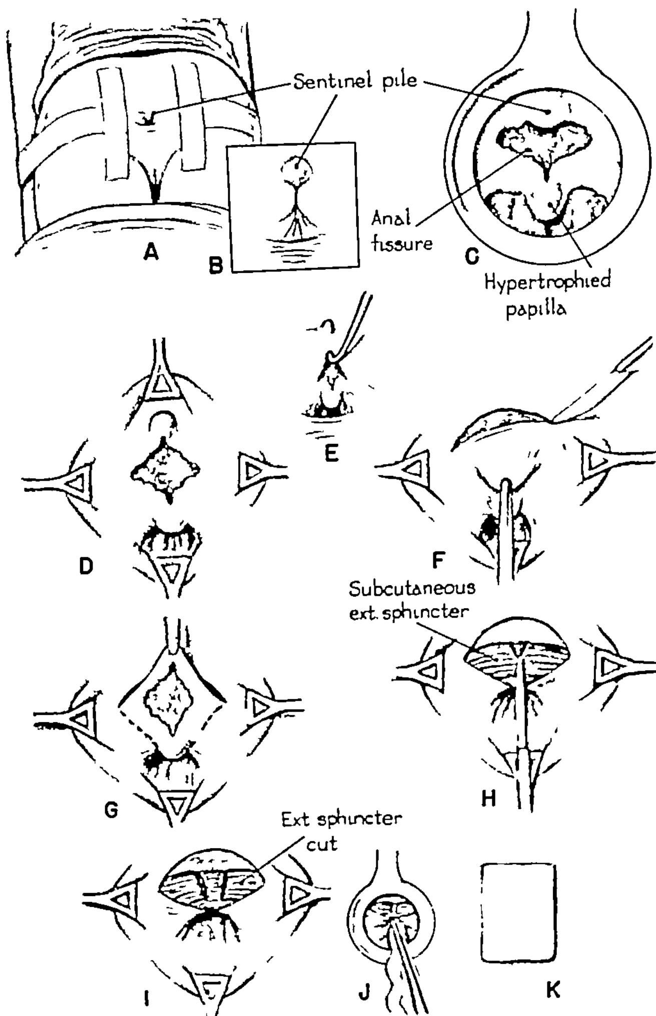
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Plate 178


Sentinel pile
Anal fissure
Hypertrophied papilla
A
B
C
D
E
F
Subcutaneous ext. sphincter
G
H
Ext sphincter cut
I
J
K

EXCISION OF FISTULA IN ANO

A. The patient is placed in the prone modified "jackknife" position (Buie), and the buttocks are separated by adhesive straps to expose the external opening of the fistula (seven o clock) in relation to the anal orifice.

B C. With the index finger in the anal canal for palpation, a probe is inserted through the external orifice of the fistula into the fistulous tract (B) and then through the in ternal opening into the anal canal (C).

D The terminal portion of the probe, bent on itself is extruded through the anal orifice, and the overlying tissue along the length of the fistulous tract is incised as indicated by the dotted line.

E, F The chronically infected fibrous tissue base of the fistula and the surrounding indurated tissues are elliptically excised as demonstrated.

G H. The new bed formed by healthy subcu taneous fatty tissue is loosely packed with a dry sterile gauze packing and subsequently covered with a compression gauze dressing to complete the operation. Excision of the fistula and primary closure of the defect is neither practiced nor recommended.

DISCUSSION—DR. CON AMORE V BURT Fistulas in ano may vary widely in degree and extent. I agree in general with the procedure of Dr Madden in the very simple fistula. Most of mine, however do not seem to be so simple. Again, there are usually associated internal hemorrhoids and generally many enlarged anal crypts from which most anal abscesses and subsequent fistulas result. It is my practice to always remove these hemorrhoids and crypts rather than subject the patient to another operation. Also, I think the wound heals better if these are removed at the same time.

In many instances in the more extensive fistulas, it is my usual practice to excise completely the fistulous process and repair the internal and external sphincters at the same time. This has saved many patients from some degree of incontinence and fur ther operations. To promote proper drainage it is important to leave the skin and subcutaneous tissue open without suturing.

It is desirable to prepare the bowel with antibiotics and proper cleansing preoperatively It seems to make little difference postoperatively whether the patient is kept without a bowel movement for 8 or 10 days or is given mineral oil and cathartics to promote normal function.

Many of these repaired sphincters become infected, and it is necessary to cut through the repair within 8 to 10 days postoperatively However the retraction of the sphincter ends is minimal, and usually incontinence is either minimal or absent. In the extensive fistulas, if the sphincters are not repaired, consider able incontinence is frequently observed.

If the fistula extends up along or close to the vaginal wall, it is extremely important to keep one finger in the vagina during the dissection. It is easy to buttonhole the vaginal wall and produce a rectovaginal complication.

Where previous operations have destroyed much of the sphincters, it is sometimes necessary to do a preliminary colostomy Otherwise the repair of the fibrous-tissue-laden structures will not be successful.

The use of zinc peroxide, antibiotics, mineral oil, cathartics, and postoperative dilation once or twice a week to prevent adhesions and to relax the sphinc ters is similar to the postoperative care after hemor rhoidectomy

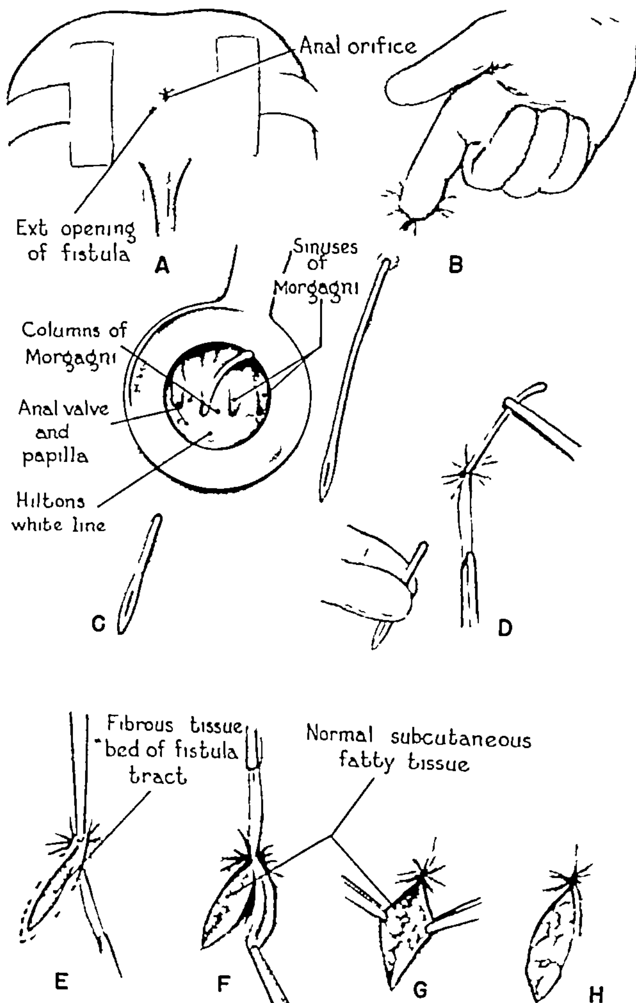
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Anal orifice
Ext opening of fistula
A
B
Sinuses of Morgagni
Columns of Morgagni
Anal valve and papilla
Hiltons white line
C
D
Fibrous tissue bed of fistula tract
Normal subcutaneous fatty tissue
E
F
G
H

HEMORRHOIDECTOMY

A B. The muscle structures of the perianal region (A) and the relation of the external and internal hemorrhoidal plexuses to the intermuscular septum and the adjacent muscles (B) are visible

C. The patient is placed in the prone, modified "jackknife" position (Buie), and the ends of two gauze strips are protruded through the lumen of the anoscope previously inserted into the anal canal and lower rectum.

D E. The anoscope is withdrawn over the gauze strips (D) which are subsequently withdrawn to evert the hemorrhoidal masses (E) With the patient in the prone position, the location of each primary hemorrhoid is shown. The subsequent steps in the illustrated technic are based on the principles set forth by Milligan of England.

F Four Pennington clamps are placed equidistant from each other about the anal orifice, and a curved clamp is applied to the dentate line in relation to the primary hemorrhoid at one o clock.

G The Pennington clamp laterally is removed, and, with medial traction on the hemorrhoid through the curved clamp an angular incision extending well on to the cutaneous margin is made laterally (dotted lines).

H. The tip of the cut margin of the angular incision is grasped in a clamp and by a combination of traction and scalpel dissection the hemorrhoid is mobilized. In this mobilization the dissection is behind the hemorrhoidal mass and continued well beyond the subcutaneous external sphincter muscle which is an important anatomic landmark to be identified. Bleeding is usually minimal when this technic is used.

DISCUSSION—DR. CON AMORE V BURT It is my practice to place the patient in the lithotomy position, mainly because of the greater ease of administration of gas-oxygen anesthesia which I use as a supplement to local anesthesia-analgesia (eucupin in oil). Local anesthesia is fraught with some danger of abscess formation, but this has proved an infrequent complication. However if the local anesthesia is not pooled and is evenly distributed there is diminution of postoperative pain and relaxation of the sphincters.

It is important to dilate the sphincters but not divulse or tear them. The sphincters are completely relaxed after the local in oil is placed subcutaneously and submucosally in the anal canal. Caution is observed to avoid injection into the muscles. The use of gauze for eversion of the hemorrhoids has not been necessary in my experience. I place Allis clamps anteriorly and bilaterally on the skin at the anal verge or over the subcutaneous sphincter With gentle traction on these clamps, the hemorrhoids are completely exposed.

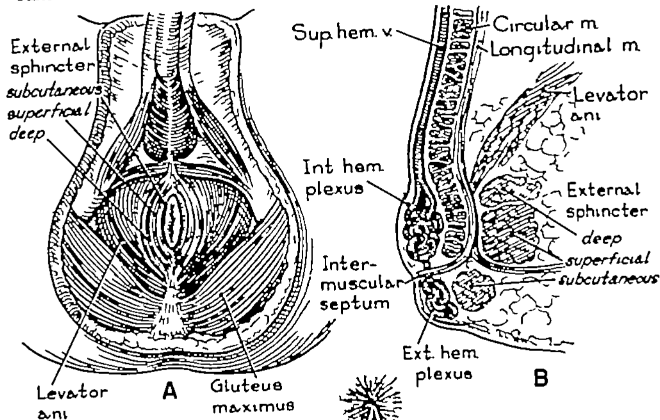
My primary incision is the same as shown in Plate 180 G and H, so as to include all of the redundant external tags. It is our objective to leave the perianal area streamlined. The patients object to tags postoperatively and they are interpreted to be persistence of the hemorrhoids. In the excision, it is important to include the smaller or secondary hemorrhoids. One should be careful not to excise too high and too wide both in the internal and external hemorrhoidal zones, as this contributes to postoperative anal stenosis.

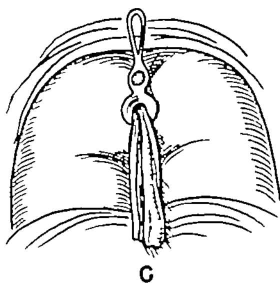
It is my practice to ligate the pedicle as shown in Plate 181 K and L, and then close the skin margins with the same suture running out to the anal verge. It is very important to leave open one area of excision, usually posteriorly so that good drainage is provided. This reduces postoperative edema and discomfort. The drainage tract should extend outside the verge so that the external wound does not heal earlier than the wounds in the anal canal.

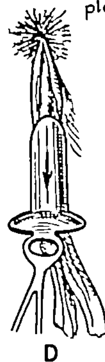
To reduce postoperative pain further I usually instruct patients to eat lightly the day before operation and to take achromycin tablets (250 mg.) three times a day for three days preoperatively to sterilize the colon contents. An enema is given the day before operation and a sedative at bedtime. Postoperatively antibiotics for four or five days, hot sitz baths and mineral oil (1 ounce) twice daily and a cathartic the evening of the first postoperative day are prescribed. The mineral oil is continued until the wound is healed, which is about one month after operation.

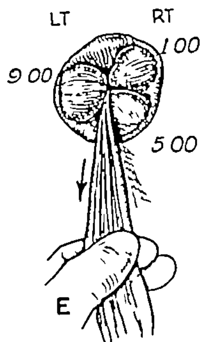
At the completion of the operation, I place in the anal canal about six wicks of 1-inch gauze (folded) soaked in a zinc peroxide suspension. This is bacteriostatic for the anaerobic organisms, comes away easily and reduces the odor

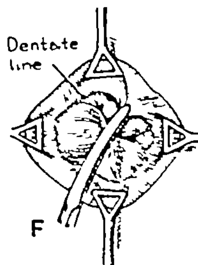
Plate 180

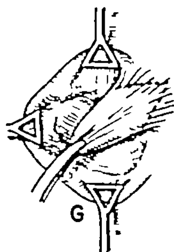

External
sphincter
subcutaneous
superficial
deep
Levator
ani
A
Gluteus
maximus
Sup. hem. v.
Circular m.
Longitudinal m.
Levator
ani
Int. hem.
plexus
External
sphincter
deep
superficial
subcutaneous
Inter-
muscular
septum
Ext. hem.
plexus
B

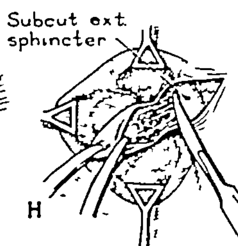

C


D


LT
RT
1 00
9 00
5 00
E


Dentate
line
F


G


Subcut. ext.
sphincter
H

I. Following completion of the dissection posteriorly the hemorrhoidal mass is displaced laterally and the angular incision to be made in the mucous membrane is shown (dotted lines).

J The mobilized hemorrhoidal mass is again displaced medially and a ligature of 00 chromic catgut is being applied to the base of its pedicle.

K, L. The pedicle is doubly clamped and severed (dotted line) distal to the ligature (K), and a suture ligature of 00 chromic catgut is inserted in the pedicle between the remaining clamp and ligature (L).

M The location of the ligature on the hemorrhoidal pedicle in relation to the external and internal hemorrhoids and the subcutaneous external sphincter is shown.

N The mobilization of the primary hemorrhoid at five o clock is being completed as previously described.

O Upon completion of the hemorrhoidectomy the anoscope is reinserted, and the ligated pedicle of each primary hemorrhoid and the adjacent raw surfaces are carefully inspected for bleeding. If bleeding is present, hemostasis is obtained with suture ligatures of 00 chromic catgut. The stellate appearance formed by the raw surfaces after excision of the three primary hemorrhoids is visible. *The extension of the incisions well onto the cutaneous margins minimizes post operative tissue edema and pain.* The insertion of a thin petrolatum gauze wick and the application of a sterile compression dressing complete the operation Postoperative sedation is prescribed as required. The day after operation the vaseline gauze strip is removed and sitz baths twice daily are prescribed. Mineral oil (1 ounce) twice daily for four days is also prescribed Subsequently mineral oil (1 ounce) is ingested once a day every other day for the next seven days.

A B C, D The technic for removal of a thrombotic external hemorrhoid is depicted. Using 0.5 ml. of procaine (1 per cent) a weal is raised in the mucous membrane overlying the thrombus (A) *The mucous membrane is incised, and a portion of the overlying thrombus is visible (B)* By blunt tissue dissection with a clamp the thrombus is evacuated (C, D) Bleeding is usually minimal and readily controlled by momentary pressure with a dry gauze sponge.

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I J

Subcut. ext sphincter

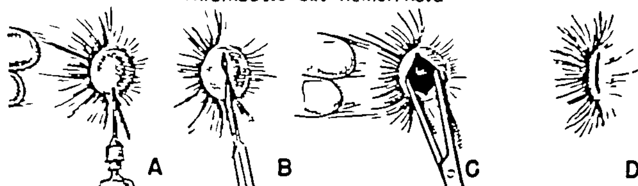
K L M

Int. Ext. hemorrholds

N O

Petrolatum gauze wick

Thrombotic ext hemorrhoid



LEFT HEPATIC LOBECTOMY

A. The longitudinal left upper quadrant paramedian muscle-retracting (lateral) incision employed and the horizontal T shaped extension to the right, which was required subsequent to exploration, are indicated in dotted outline

B. The peritoneal cavity is entered, and the large protuberant tumor mass in the left lobe of the liver may be seen. The horizontal extension of the incision in the peritoneum is indicated by the dotted line.

C. The tumor mass, soft in consistency is displaced digitally to the left as its fibrous tissue attachments are severed by scissor dissection.

D E. The mobilization of the tumor mass is continued, and its deeper attachments to the anterior wall of the stomach and the left lobe of the liver are exposed and severed as indicated (E).

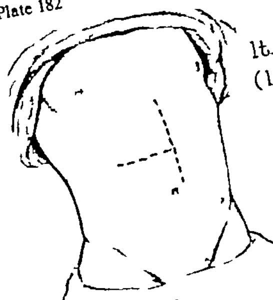
DISCUSSION—DR. ALEXANDER BRUNSCHWIG The incision as illustrated in Plate 182, A, is unusual for exposure of the left lobe. I employ the high midline or left paramedian incision with horizontal component extending to the left. Under certain circumstances, I use a left high paramedian incision, with the upper end curving toward the left over the costal arch and transecting the arch without necessarily entering the left thoracic cavity (or pericardium). Division of the costal arch adds to retractability of the exposure incision

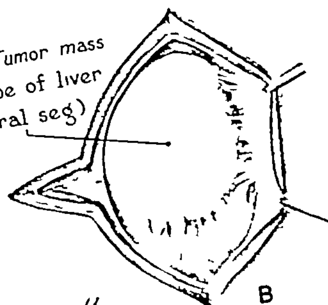
Usually the left lobe does not have numerous adhesions about it. In some instances the left lobe may be quite adherent to a carcinoma of the stomach, this lobe is then excised en masse with the stomach.

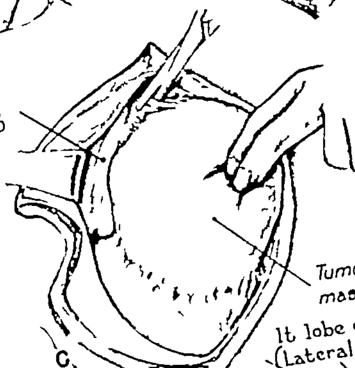
Detachment of the falciform ligament may or may not be necessary but, when carried out, it certainly adds mobility to the left lobe.

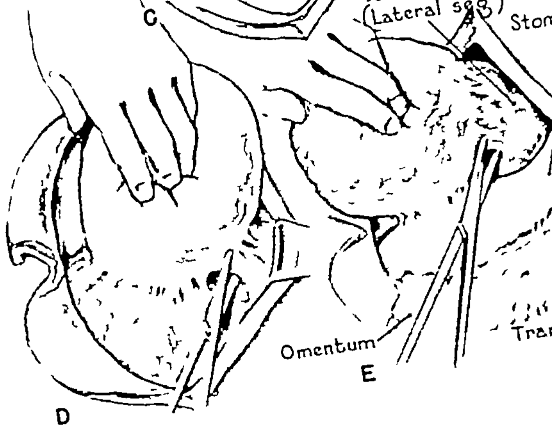
In this case, the tumor in the left lobe was removed separately but usually the tumor and the left lobe are excised en masse. Benign or even malignant neoplasms sometimes are easily "cored out" of the liver and there is surprisingly little bleeding from the bed. This is not often done intentionally

Plate 182


A


Tumor mass
lt. lobe of liver
(lateral seg)
B


Falciform lig
Tumor
mass
C


lt lobe of liver
(Lateral seg)
Ston
Omentum
Tran
E
D

LEFT HEPATIC LOBECTOMY

A. The longitudinal left upper quadrant paramedian muscle-retracting (lateral) incision employed and the horizontal T shaped extension to the right, which was required subsequent to exploration, are indicated in dotted outline.

B. The peritoneal cavity is entered, and the large protuberant tumor mass in the left lobe of the liver may be seen. The horizontal extension of the incision in the peritoneum is indicated by the dotted line.

C. The tumor mass soft in consistency is displaced digitally to the left as its fibrous tissue attachments are severed by scissor dissection.

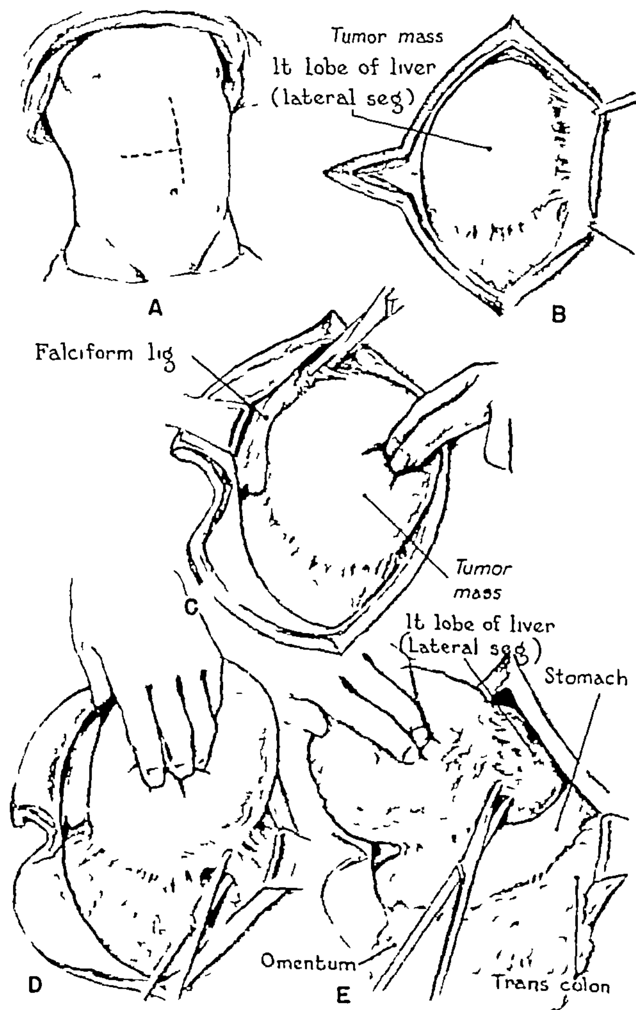
D E. The mobilization of the tumor mass is continued, and its deeper attachments to the anterior wall of the stomach and the left lobe of the liver are exposed and severed as indicated (E)

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In this case, the tumor in the left lobe was removed separately but usually the tumor and the left lobe are excised en masse. Benign or even malignant neoplasms sometimes are easily "cored out" of the liver and there is surprisingly little bleeding from the bed. This is not often done intentionally


Tumor mass
lt lobe of liver
(lateral seg)
A
B
Falciform lig
Tumor
mass
C
lt lobe of liver
(Lateral seg)
Stomach
Omentum
Trans colon
D
E

F The dissection of the soft friable tumor mass from its bed in the lateral segment of the left lobe of the liver is completed. The tumor a primary hepatoma, felt like a large incompletely organized hematoma. The removal of the protuberant portion of the tumor mass was not associated with undue hemorrhage and permitted the exposure of the underlying lateral segment of the left lobe of the liver and its contained residual tumor

G. The left and right lobes of the liver are retracted upward to expose the site of the incision (dotted line) to be made in the gastrohepatic ligament.

H The incision in the gastrohepatic and the hepatoduodenal ligaments is completed, and the underlying vascular and ductal structures are depicted. The large lymph node uniformly present overlying the hepatic artery just distal to its bifurcation into hepatic propria and gastroduodenal branches, and the node characteristically found lateral to the terminal portion of the common bile duct are visible.

I. The left lobe of the liver is manually depressed downward, and its mobilization is begun by severance (dotted line) of the avascular left triangular ligament by scissor dissection

DISCUSSION—DR. BRUNSCHWIG (cont.)

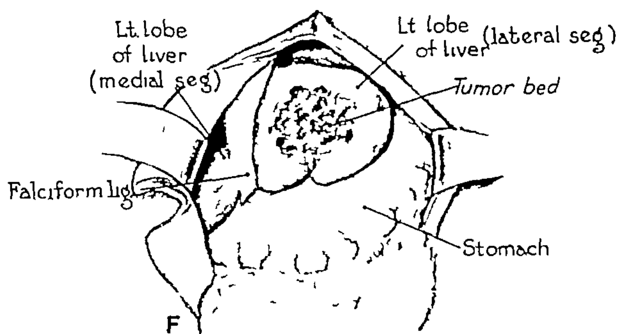
The approach to the porta hepatis is well illustrated in Plate 183 G and H, and, in the absence of fat and edema in the gastrohepatic ligament, the structures depicted may be fairly well visualized and palpated before any dissection is begun. During the identification and isolation of the left branch of the hepatic artery and left branch of the portal vein, it is very important to be on the alert for anomalies in the distribution of these vessels. As a matter of principle, they should be transected as near the liver as feasible. The right and left hepatic ducts join at varying levels, and the actual confluence may be partially or entirely within the hepatic parenchyma. The left hepatic artery and the left branch of the portal vein are the important structures to divide before the left hepatic duct is secured, although, for exposure, early transection of the left hepatic duct may be necessary When the left hepatic artery and the left portal vein branch are divided, almost all of the left lobe will assume a dark bluish hue.

In dividing the left triangular ligament over the dome of the left lobe, care must be exercised as the transection is carried toward the midline, because an anomalous left hepatic vein within the mesial portion of the ligament may be inadvertently opened, with consequent severe hemorrhage

The transection of the base of the left lobe is depicted in Plate 184 J as beginning above and progressing downward. Personally I begin this transection below and proceed upward—separating parenchyma by a somewhat teasing motion with the scalpel or by using the scalpel handle for such blunt dissection. In this manner the left lobe becomes finally detached except for the left hepatic vein, which is then doubly clamped and transected.

The inset Plate 184 J depicts the true anatomic lobar division of the liver Thus, if left hepatic lobectomy is defined as resection of the tissue to the left of the falciform ligament, it really represents resection of the left lateral segment of the liver

The method, depicted in Plate 184 M, of covering the transected stump of the left lobe by turning the falciform ligament downward is one of several methods followed as a final step in this operation. Any method that a surgeon uses and that is found to give satisfaction may be employed. Personally I leave perhaps a little more stump to the left of the falciform ligament and, as a final step, insert an over and over parenchymal compressing suture of No 2 chromic catgut on a blunt tipped large curved needle. The bites are taken through each margin of the base —anteriorly and posteriorly If oozing is a little more marked, I tamponade the cut surface with long 4-inch wide gauze pack, allowing the end to protrude from the upper end of the wound. The pack is removed in toto in three or four days under pentothal anesthesia. One or two large soft rubber drains are inserted to the region of the lesser curvature of the stomach and brought out through a stab wound to the left of the midline incision.



G

Caudate lobe
Hepatic propria
Lt hepatic a
Rt. hepatic a
Hepa-tic a
Lig stump rt gastric a
H
Cystic d
Common d
Gastroduodenal a
Sperm. v. & a
Inf VC
Lymph nodes
Duod

Diaphragm
Lt triangular lig
I

F The dissection of the soft friable tumor mass from its bed in the lateral segment of the left lobe of the liver is completed. The tumor a primary hepatoma, felt like a large incompletely organized hematoma The removal of the protuberant portion of the tumor mass was not associated with undue hemorrhage and permitted the exposure of the underlying lateral segment of the left lobe of the liver and its contained residual tumor

G The left and right lobes of the liver are retracted upward to expose the site of the incision (dotted line) to be made in the gastrohepatic ligament.

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DISCUSSION—DR. BRUNSCHWIG (cont.)

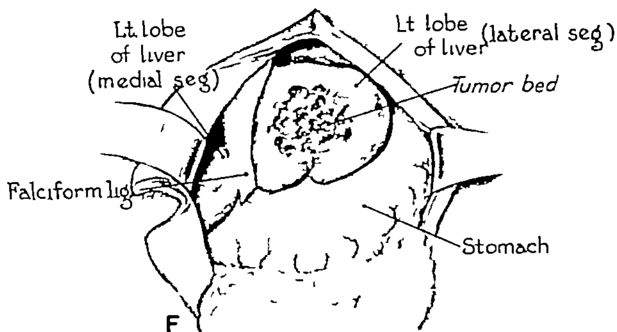
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G

Caudate lobe
Hepatic propria
Lt hepatic a
Rt. hepatic a
Hepatic a
Lig stump rt gastric a
H
Cystic d
Common d
Gastroduodenal a.
Sperm v. & a
Inf VC
Lymph nodes
Duod

Diaphragm
Lt trianqular liq
I

J The ligation and transection of the left hepatic duct, the left hepatic artery and the left hepatic tributary of the portal vein are completed, and the resection of the lateral segment of the left lobe of the liver is begun by severance (scalpel) of the liver parenchyma in the intersegmental tissue plane between the medial and lateral segments of the left lobe of the liver This plane is frequently and incorrectly referred to as the interlobar tissue plane. However the true interlobar plane bisects the fossa of the gallbladder and the fossa of the inferior vena cava respectively (J) Accordingly the left lobe of the liver is anatomically separated into two segments (1) a medial segment located between the true interlobar plane previously mentioned and the falciform ligament (2) a lateral segment between the falciform and left triangular ligaments which is commonly and incorrectly referred to as the left lobe of the liver (J) A portion of the left hepatic vein tributary is visible. This vein drains the entire lateral segment of the left lobe and the superior area of the medial segment of the left lobe of the liver It normally unites with the middle hepatic vein to form a common hepatic venous trunk, as first stressed by Rex, which empties into the inferior vena cava The middle hepatic vein drains the inferior area of the anterior segment of the right lobe and the inferior area of the medial segment of the left lobe of the liver In the performance of a resection of the whole of the lateral segment of the left lobe of the liver the potential danger of inadvertently ligating the common venous channel formed by the left hepatic and middle hepatic veins is decidedly less when compared to the performance of a right hepatic lobectomy as is subsequently shown.

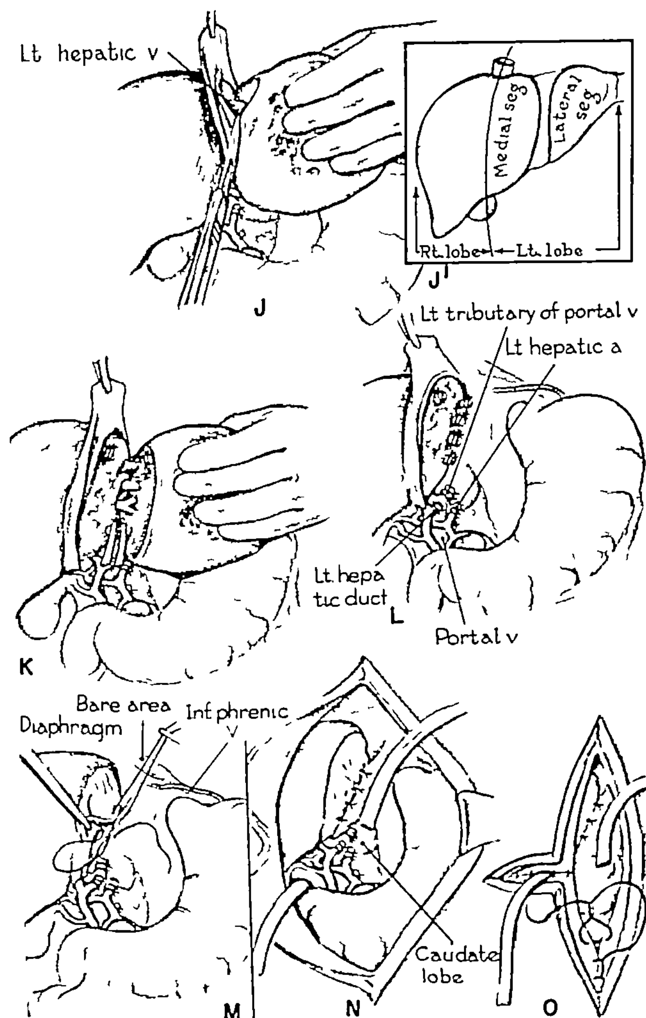
J[1] This inset shows schematically the plane of the true lobar division of the liver into right and left lobes. This plane bisects the gallbladder and inferior vena cava respectively The separation of the left lobe into medial and lateral segments is also depicted. Accordingly it is an error in anatomy to speak of the lateral segment of the left lobe as if it were the whole left lobe of the liver

K L. The left hepatic vein tributary is severed and ligated, and the incision in the liver parenchyma is deepened to the plane of the tributaries of the left portal vein between the medial and lateral segments of the left lobe of the liver This is accomplished with negligible bleeding because of the preliminary extrahepatic ligation of the vascular supply to the left lobe of the liver The intersegmental tributaries of the left portal vein are individually doubly clamped, severed (dotted line) (K), and ligated (L) to complete the total resection of the lateral segment of the left lobe of the liver (L). The ligated stumps of the vascular and duct structures to the left lobe of the liver are visible.

M. The resection of the whole of the lateral segment of the left lobe of the liver is completed, and the raw surface of the medial segment of the left lobe is covered by the falciform ligament which is anchored to the subjacent tissues with sutures of 000 silk.

N The operative field, upon completion of the operation and the insertion of two cigarette drains (Penrose) is shown.

O The wound closure is in layers, using a continuous interlocking double strand suture of 00 chromic catgut for the peritoneum, as shown, interrupted sutures of 00 silk for the fascia, and 000 silk for the skin. The drains have their exit through the incision rather than through adjacent stab wounds.


Lt hepatic v
Medial seg
Lateral seg
Rt. lobe
Lt. lobe
J
J'
Lt tributary of portal v
Lt hepatic a
Lt. hepatic duct
L
Portal v
K
Bare area
Diaphragm
Inf phrenic v
Caudate lobe
M
N
O

A. The right side of the patient is elevated on a pillow support, somewhat higher than that indicated in the illustration, and the thoracoabdominal incision (ninth interspace) routinely employed is shown by the solid black line.

B. The incision is completed to convert the peritoneal and right pleural cavities into one common cavity The resultant exposure of the underlying viscera is shown.

C. The right lobe of the liver is manually displaced toward the midline preparatory to severance of the right triangular ligament by scissor dissection.

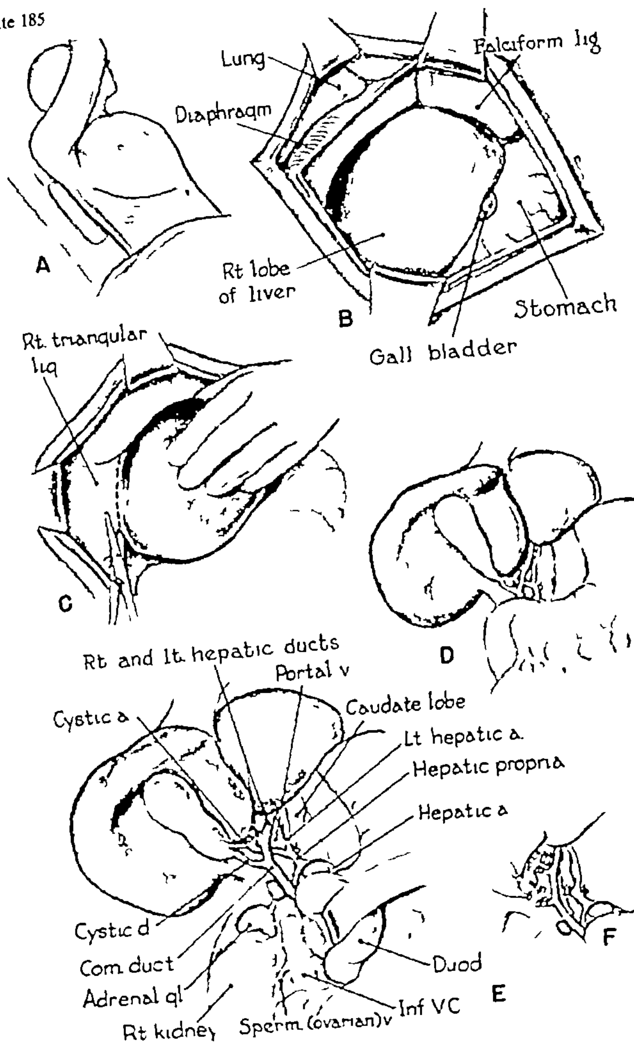
D E. The undersurface of the liver is exposed, and the gastrohepatic and hepatoduodenal ligaments are incised to demonstrate the structures within the hepatic trinity In E, these structures are more clearly defined, and the retrocolic portion of the duodenum is mobilized and retracted toward the mid line to show the subjacent retroperitoneal structures. The right adrenal gland in relation to the superior pole of the kidney and the entrance of the right adrenal vein into the inferior vena cava are also visible. The characteristic locations of the lymph nodes, in relation to the hepatic artery and the distal portion of the common duct are depicted

F This is a schematic illustration to show the completion of the ligation and severance of the right hepatic artery the cystic duct, the right hepatic duct, and the right hepatic tributary of the portal vein. The passage of the portal vein beneath the arch formed by the gastroduodenal branch of the hepatic artery is also visible. This is an important anatomic landmark surgically for the identification of the portal vein.

DISCUSSION—DR. ALEXANDER BRUNSCHWIG The incision as depicted in Plate 185 A, indicates more of a thoracic than an abdominal component. In making thoracoabdominal exposure for the right hepatic lobectomy I usually perform a high right rectus incision with extension of the upper end obliquely upward to the right and over the costal arch in the eighth interspace for not more than 4 inches. The right cartilaginous costal arch is severed, and the *diaphragm is split down to the inferior vena cava* After transection of the right triangular ligament and division of the falciform ligament, the whole liver is rotated upward. The incision described permits free access to the porta hepatis as indicated in Plate 185 E. I usually do not mobilize duodenum and head of pancreas as shown, nor do I particularly visualize the right suprarenal gland. The first step that I carry out is isolation and transection of the cystic duct. The right branch of the hepatic artery the right branch of the portal vein, and the right branch of the hepatic duct are identified, isolated, and transected well out to the right in the porta hepatis rather than in the midportion of this region. After the right hepatic artery and the right branch of the portal vein are divided, most of the right lobe turns a bluish color with a 2 to 3 cm. wide zone of the right lobe to the right of the falciform ligament retaining its normal color In Plate 186 G H, and I, the rotation of the right lobe to the left to expose the hepatic veins going into the vena cava is well demonstrated. As soon as they are identified, they are doubly clamped with small hemostats and ligated, using silk for all the ligatures. There may be considerable variation in the anatomy of the principal hepatic vein draining the right lobe and emptying into the inferior vena cava, also, in the large central hepatic vein, which may enter the inferior vena cava directly or join with the right hepatic vein to form a common trunk or even join with the left hepatic vein to form a large single hepatic vein emptying into the vena cava. Not infrequently I search for the terminations of the right hepatic vein and the central hepatic vein by permitting the right lobe to fall back into normal position and inserting a retractor over *the upper surface of the liver just to the right of the* falciform ligament. When this retractor is pulled downward, the large trunks mentioned above can sometimes be visualized as they go into the inferior vena cava. Thus, they can be traced backward into the liver where they may be secured and divided. Some blunt dissection with the scalpel handle may greatly facilitate the exposure.

Too much emphasis cannot be placed upon the importance of isolation of the large right and middle hepatic veins with sparing of the left hepatic veins during right hepatic lobectomy It is in carrying out these steps that very severe hemorrhage might arise, and, of course, in clamping bleeding areas, great care must be exercised not to clamp too much. Likewise, in clamping and dividing the shorter and smaller hepatic veins coming from the lower portions of the right lobe directly into the vena cava, great care must be taken to avoid tearing the inferior vena cava itself, since such tearing may lead to disaster The distribution of hepatic veins, their size, and the ease with which they are isolated and clamped may be seriously altered by the presence of large bulky tumor masses in the right lobe. Such tumor bearing right lobes are extremely friable, and, even with the most gentle manipulation, the right lobe may sud-

Plate 185



A
Lung
Diaphragm
Falciform lig
Rt lobe of liver
Stomach
B
Gall bladder
Rt. triangular lig
C
D
Rt and lt. hepatic ducts
Portal v
Caudate lobe
Cystic a
Lt hepatic a.
Hepatic propria
Hepatic a
Cystic d
Com. duct
Adrenal gl
Rt kidney
Sperm. (ovarian) v
Inf VC
Duod
E
F

G H. The right lobe of the liver is manually retracted toward the midline as dissection of the "bare" area (G) enclosed by the attachments of the right triangular ligament, is continued to expose the inferior vena cava and its two major right hepatic vein tributaries, two minor right hepatic vein tributaries, and right adrenal vein tributary (H).

I. The ligation and severance of the first plane of hepatic veins which drain the right lobe of the liver is completed, and the second plane of smaller hepatic veins draining the posterior surface of the right lobe of the liver is visible.

J The ligation and severance of the first and second planes of hepatic veins which drain the right lobe of the liver are completed, and the formation of a common hepatic vein tributary of the inferior vena cava by the union of the middle and left hepatic veins, as previously mentioned in the description of left hepatic lobectomy may be seen. Accordingly in the performance of a right hepatic lobectomy it is most important that the middle hepatic vein be ligated proximal to this common channel of communication to prevent obstruction of the venous drainage of the lateral segment of the left lobe of the liver through the left hepatic vein.

K. The right lobe of the liver is replaced into its normal position, and the hepatic parenchyma is incised (scalpel) to the plane of the intersegmental tributaries of the left portal vein. The union, within the liver substance, of the middle and left hepatic veins, draining the medial and lateral segments respectively of the left lobe of the liver to form a common hepatic vein tributary of the inferior vena cava is again visible. The danger of compromise of the venous outflow of the lateral segment of the left lobe of the liver by inadvertent ligation of the common channel of communication rather than selective ligation of the middle hepatic vein is apparent.

L. The hepatic parenchyma is incised in the intersegmental plane to the right of the falciform ligament to expose the intersegmental tributaries of the left portal vein, which are doubly clamped and severed (dotted line) prior to ligation (00 silk). As previously stated in reference to left hepatic lobectomy if preliminary extrahepatic selective ligation of the vascular supply to the right lobe of the liver is performed, there is minimum bleeding from the incised liver tissue.

Discussion—Dr. Brunschwig (cont.)

denly fissure or splinter causing severe hemorrhage. Another point to emphasize in regard to the shorter hepatic veins entering the vena cava below the entrance of the one or two large hepatic veins mentioned above is the fact that the shorter veins might be draining both lobes of the liver even though they appear to enter the vena cava entirely from the right lobe.

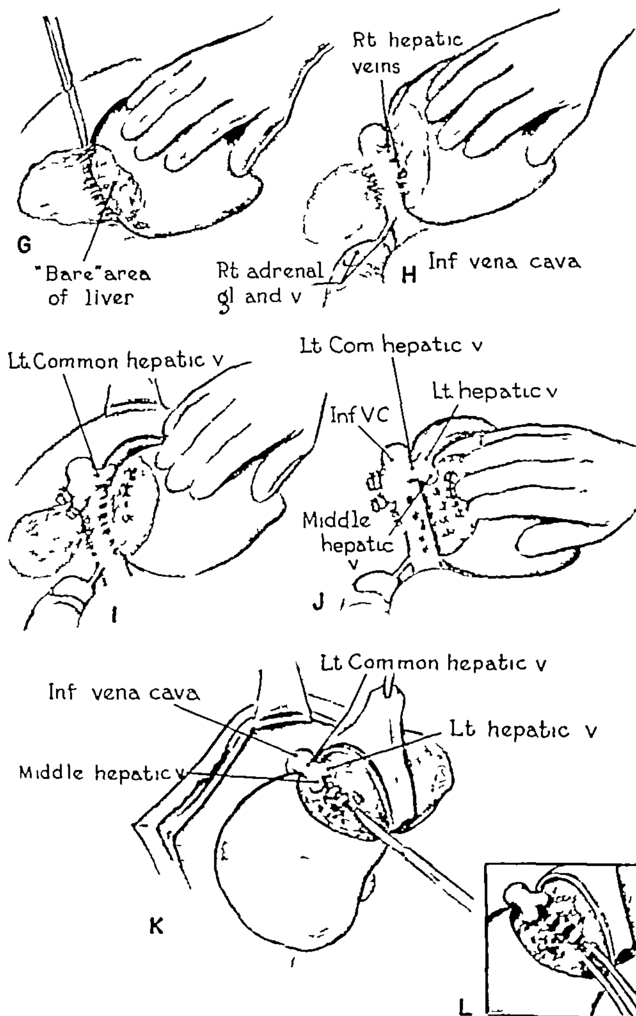
It is my own practice to transect the base of the right lobe 1½ to 2½ cm. to the right of the falciform ligament within the narrow zone of unchanged color of parenchymal tissue and accept what bleeding may occur. Such bleeding can be controlled by clamping the individual bleeding points.

The statements which I have made relative to the treatment of the stump of the left lobe apply equally well to the treatment of the stump of the right lobe.

In connection with hepatic lobectomies, I always use silk for all vessel and bile duct ligations.

I agree with the method described in terminating the operation as shown in Plate 187 O, P and Q, but in some instances I leave a hard rubber drain connected to a negative suction apparatus in the upper right portions of the abdomen for 48 or 72 hours. In some instances, although the right costal arch may be divided, actual entry into the right pleural cavity is not necessary and is not carried out. The advantages of this are obvious in that complications relative to right thoracotomy are avoided. Where the right diaphragm has been split throughout most of its length, i.e., down to the inferior vena cava, repair is made by carefully placed and tied interrupted silk or linen sutures.

An alternate method for amputation of the right lobe consists of insertion of two rows of compressing sutures 2 cm. apart and incision downward between these two rows to a depth of about 2 cm. where two more rows of compressing sutures are inserted. This procedure is continued until the whole thickness of the base of the right lobe is transected. The surgeon must be constantly on the lookout for large vessels and bile ducts. When these are seen, they are bluntly dissected, doubly clamped, ligated, and transected. This type of guillotine amputation of the right lobe may be carried out in combination with a preliminary transection of the large vessels and ducts as shown in Plate 185 E and F.



G
"Bare" area of liver
Rt hepatic veins
Rt adrenal gl and v
H
Inf vena cava
Lt Common hepatic v
I
Lt Com hepatic v
Lt hepatic v
Inf VC
Middle hepatic v
J
Lt Common hepatic v
Inf vena cava
Lt hepatic v
Middle hepatic v
K
L

G H. The right lobe of the liver is manually retracted toward the midline as dissection of the "bare" area (G) enclosed by the attachments of the right triangular ligament, is continued to expose the inferior vena cava and its two major right hepatic vein tributaries, two minor right hepatic vein tributaries, and right adrenal vein tributary (H).

I. The ligation and severance of the first plane of hepatic veins which drain the right lobe of the liver is completed, and the second plane of smaller hepatic veins draining the posterior surface of the right lobe of the liver is visible.

J The ligation and severance of the first and second planes of hepatic veins which drain the right lobe of the liver are completed, and the formation of a common hepatic vein tributary of the inferior vena cava by the union of the middle and left hepatic veins, as previously mentioned in the description of left hepatic lobectomy may be seen. Accordingly in the performance of a right hepatic lobectomy it is most important that the middle hepatic vein be ligated proximal to this common channel of communication to prevent obstruction of the venous drainage of the lateral segment of the left lobe of the liver through the left hepatic vein.

K. The right lobe of the liver is replaced into its normal position, and the hepatic parenchyma is incised (scalpel) to the plane of the intersegmental tributaries of the left portal vein. The union, within the liver substance, of the middle and left hepatic veins, draining the medial and lateral segments respectively of the left lobe of the liver to form a common hepatic vein tributary of the inferior vena cava is again visible. The danger of compromise of the venous outflow of the lateral segment of the left lobe of the liver by inadvertent ligation of the common channel of communication rather than selective ligation of the middle hepatic vein is apparent.

L. The hepatic parenchyma is incised in the intersegmental plane to the right of the falciform ligament to expose the intersegmental tributaries of the left portal vein, which are doubly clamped and severed (dotted line) prior to ligation (00 silk). As previously stated in reference to left hepatic lobectomy if preliminary extrahepatic selective ligation of the vascular supply to the right lobe of the liver is performed, there is minimum bleeding from the incised liver tissue.

DISCUSSION—DR. BRUNSCHWIG (cont.)

denly fissure or splinter causing severe hemorrhage. Another point to emphasize in regard to the shorter hepatic veins entering the vena cava below the entrance of the one or two large hepatic veins mentioned above is the fact that the shorter veins might be draining both lobes of the liver even though they appear to enter the vena cava entirely from the right lobe

It is my own practice to transect the base of the right lobe 1½ to 2½ cm. to the right of the falciform ligament within the narrow zone of unchanged color of parenchymal tissue and accept what bleeding may occur Such bleeding can be controlled by clamping the individual bleeding points.

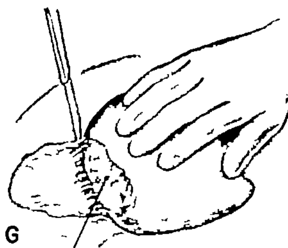
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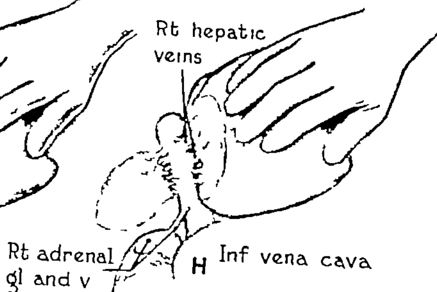
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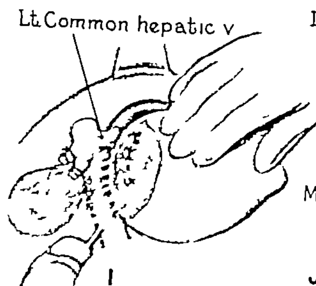
I agree with the method described in terminating the operation as shown in Plate 187 O P and Q, but in some instances I leave a hard rubber drain connected to a negative suction apparatus in the upper right portions of the abdomen for 48 or 72 hours

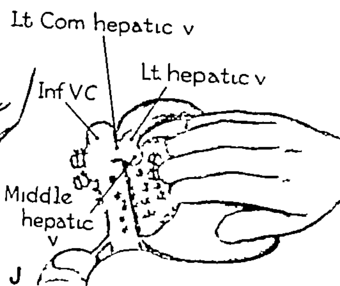
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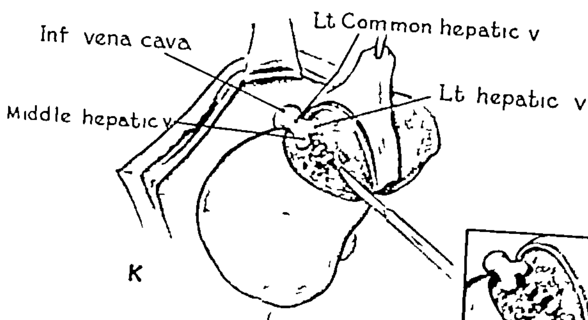
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G
"Bare" area of liver


Rt hepatic veins
Rt adrenal gl and v
H
Inf vena cava


Lt Common hepatic v
I


Lt Com hepatic v
Inf VC
Lt hepatic v
Middle hepatic v
J


Inf vena cava
Lt Common hepatic v
Lt hepatic v
Middle hepatic v
K


L

M. *The middle hepatic vein, which drains the* inferior area of the anterior segment of the right lobe and the inferior area of the medial segment of the left lobe of the liver is clamped and severed, and its cephalad end is occluded with a ligature and a suture ligature respectively of 00 silk

N O The right hepatic lobectomy is completed (N), and the raw surface of the lateral segment of the left lobe of the liver is covered by suture (000 silk) of the falciform ligament to the subjacent structures (O).

P *The operative field, upon completion of the* operation and the insertion of a cigarette drain (Penrose), is shown.

Q The wound is closed in layers Water-seal drainage (Foley catheter No 16 F) of the right pleural cavity through a stab wound site subjacent to the incision is routinely practiced. The intraperitoneal drain has its exit through the abdominal incision rather than through a separate stab wound drainage site.

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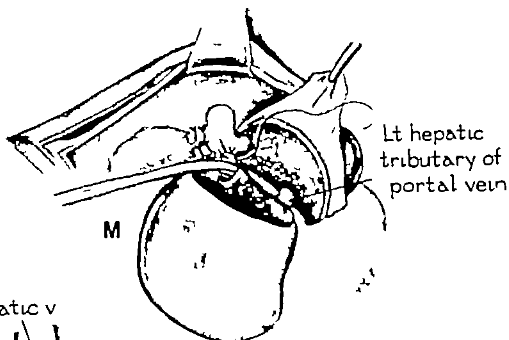
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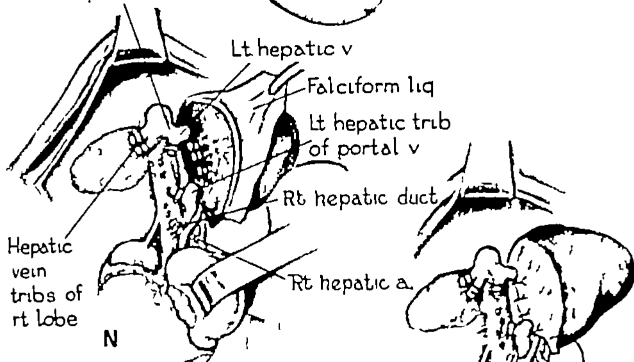
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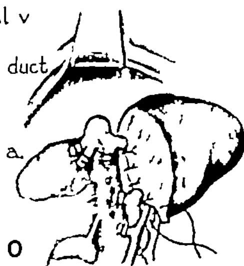
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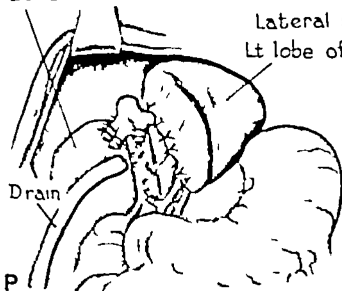
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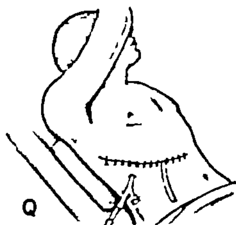
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Lt hepatic
tributary of
portal vein
M


Left
Com hepatic v
Lt hepatic v
Falciform lig
Lt hepatic trib
of portal v
Rt hepatic duct
Hepatic
vein
tribs of
rt lobe
Rt hepatic a.
N


O


Bare area
Lateral seg
Lt lobe of liver
Drain
P


Q

CHOLECYSTECTOMY

A. An oblique right paramedian muscle-retracting (lateral) incision, depicted by the solid black line, is the one of choice. If preferred, either a subcostal or transverse incision, as shown in dotted outline, may be used.

B, C. The anterior rectus sheath is incised, and the medial border of the right rectus muscle is mobilized by a combination of sharp and blunt dissection from its midline attachment and retracted laterally. Accordingly the nerve supply to the muscle is not interrupted.

D, E. Upon entrance into the peritoneal cavity the intraperitoneal and the adjacent retroperitoneal viscera are carefully explored, and a record of the findings is made. A curved (Kelly) clamp is placed upon the fundus of the gallbladder and the right hand is inserted over the dome of the right lobe of the liver into the subphrenic space. The clamp on the gallbladder is held in the left hand, and, while traction is maintained upward, the right hand is used to rotate manually both the inferior surface of the liver and the gallbladder into the operative field (E).

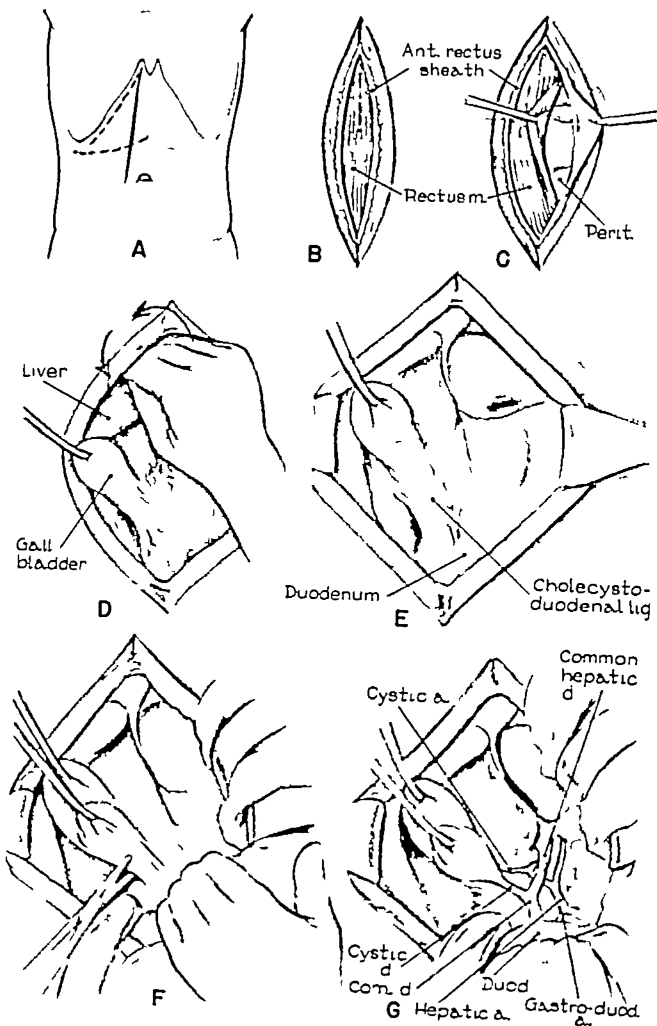
F. To isolate the operative field, three medium sized moist gauze pads are used. One is placed over the anterior surface of the stomach, another is inserted into the hepatorenal (Morison) space, and a third is placed over the transverse colon and the first portion of the duodenum. A second curved (Kelly) clamp is placed upon the gallbladder in the region of its ampulla, and, with traction maintained upward, the cholecystoduodenal ligament is made taut prior to its division by scissor dissection.

G. The dissection of the cholecystoduodenal ligament is completed to expose both the cystic duct and artery and their related structures. The long cystic duct and the origin of the cystic artery from the convex arch formed by the right hepatic artery are clearly visible.

DISCUSSION—DR. FRANK GLENN. The abdominal incision that promises the best exposure of the biliary fossae should be determined by the surgeon for each patient. Over the years it seems to me that the subcostal approach (Plate 188, A) has been the one most often used. However muscle-reflecting incisions (Plate 188 B C) are much more comfortable for the patient. Dislocation of the liver (Plate 188 D) is a useful maneuver but is not always needed if the exposure is good. Linear incisions parallel to the common duct and made just through the peritoneum after dividing any cholecystoduodenal adhesions enable one to visualize the cystic duct with minimal effort.

Identification of the cystic duct and the placing of a ligature about it enable one to place traction upon it so that the next step of identification and dissection of the cystic artery as it enters the gallbladder can be done with safety under clear vision. It is here that mistaken identity of strictures may result in common duct injury. Even where these structures are satisfactorily identified and when retrograde removal of the gallbladder is planned, it is recommended that the cystic artery be divided just proximal to its bifurcation as it enters the gallbladder wall and before the cystic duct is transected.

In retrograde removal of the gallbladder (Plate 190, P P'), sharp dissection, keeping close to the gall-


A
B
C
Ant. rectus sheath
Rectus m.
Perit.
Liver
Gall bladder
D
Duodenum
Cholecysto-duodenal lig
E
F
Cystic a.
Common hepatic d
Cystic d
Com. d
Duod
G
Hepatic a.
Gastro-duod a.

H H' I The cystic duct and the cystic artery are individually doubly clamped and severed, and the proximal ends are occluded with both ligatures and transfixion suture ligatures of silk (000). To facilitate the division of the cystic duct and artery a curved (Kelly) clamp is applied distally and a right angled (Mixter) clamp is applied proximally

J If preferred, the proximal ligatures may be applied prior to the application of clamps to either the cystic duct or artery

K L. The cystic duct and cystic artery are in turn doubly clamped and severed, and transfixion sutures of silk (000) are inserted as previously described

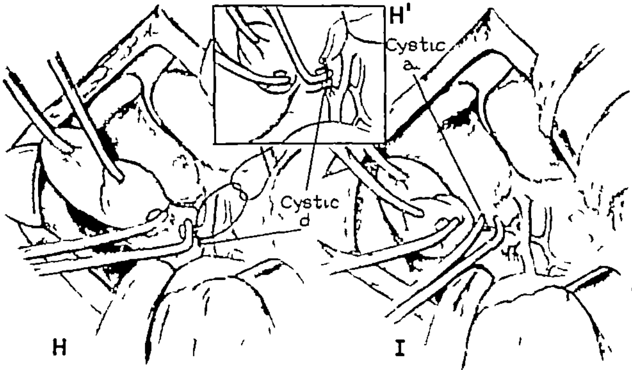
M *An unusually short cystic artery is demonstrated which permitted the application of only one clamp distal to which the artery was divided.*

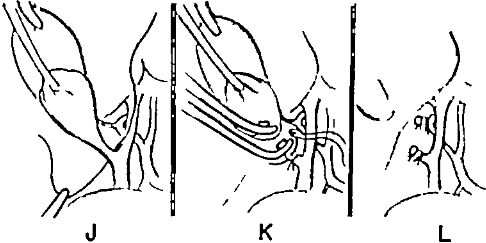
N The right hepatic artery courses anterior to the common hepatic duct, and from its convex arch a short cystic artery arises This anatomic finding demonstrates the absolute necessity for careful tissue dissection and the individual isolation of structures to lessen the chance of injury to the right hepatic artery Whenever the cystic artery is either shorter than the cystic duct (M) or anterior to the common hepatic duct (N), it is clamped and severed first *If this precaution is not observed*, there is danger of an avulsion tear of the artery with resultant hemorrhage

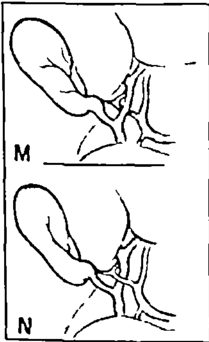
O Upon completion of the severance and ligation of both the cystic duct and cystic artery *traction is maintained upward on the* gallbladder and an incision is made through its peritoneal covering in juxtaposition to the inferior surface of the liver

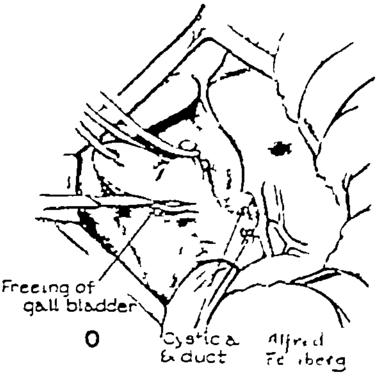
Discussion—Dr. Glenn (cont.)

bladder wall particularly in the proximal one third, enables one to visualize more readily accessory bile ducts extending from the liver into it. It also affords protection to biliary channels within the liver adjacent to the gallbladder bed Scarring and distortion of these is frequent in longstanding and recurrent cholecystitis. Every effort should be made not to cut into liver tissue. It is preferable to open into the gallbladder rather than into a bile channel in the liver Finger dissection (Plate 190, Q) may result in dividing the liver with subsequent oozing of blood and bile. Again sharp dissection enables one to avoid this. Approximation of the margins of the peritoneum from which the gallbladder was dissected (Plate 190, T U R) should be done only when it can be accomplished without tension. Meticulous attention to hemostasis and recognition of injured bile channels should precede this step if it is carried out.


H'
Cystic
a.
Cystic
d
H
I


J
K
L


M
N


Freeing of
gall bladder
O
Cystic a.
& duct

P Similarly as in O the peritoneal covering on the opposite side of the gallbladder is incised.

P[1] Q The mobilization of the gallbladder from its bed is commenced by scissor and continued by blunt digital dissection

R. Scissors are again used to complete the dissection of the gallbladder from the liver bed. An aberrant duct arising from the right hepatic duct at the porta hepatis may be seen passing across the lower portion of the gall bladder bed. A branch of the duct which entered the liver bed was inadvertently divided and required the application of a ligature as depicted.

S. After its mobilization, the gallbladder is allowed to lay on the surface of the abdomen for purpose of traction, and the liver bed is inspected for bleeding areas. The use of transfixion sutures of silk (000) for hemostasis is preferred to the various nonsuture methods.

T, U V The gallbladder bed of the liver is peritonized, and the vascular peritoneal attachment of the gallbladder to the liver is clamped, severed, and occluded with a suture ligature of silk (000)

W A portion of a Penrose (cigarette) drain is inserted into the foramen of Winslow and a layer closure of the wound completes the operation. The exit of the drain through the incision is preferred to the use of a stab wound.

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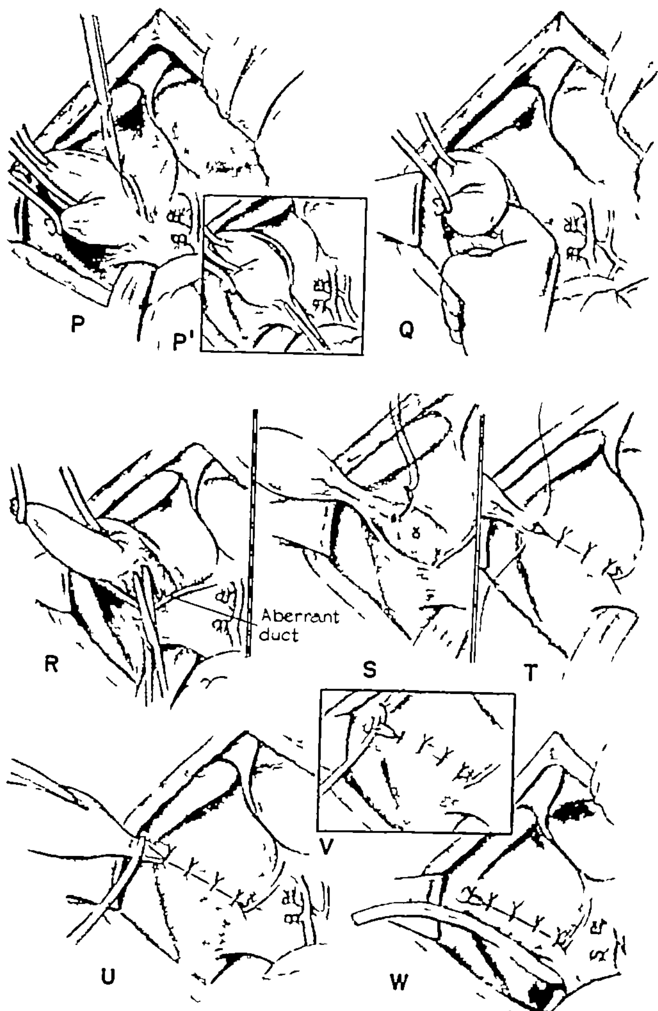
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P
P'
Q
R
Aberrant
duct
S
T
U
V
W

CHOLECYSTECTOMY FOR ACUTE CHOLECYSTITIS

In the surgical management of patients with acute cholecystitis rigid individualization is practiced. Consequently in some patients the gallbladder is removed in the acute stage, whereas in others cholecystectomy is performed as an elective procedure in a quiescent period at some later date

A. Acute cholecystitis with distention of the gallbladder and surrounding inflammatory edema.

B. The operative field is "walled off" with protective moist gauze pads and the gall bladder is decompressed, using a trocar and canula.

C. The opening in the fundus of the gallbladder is occluded with a curved (Kelly) clamp and the mobilization of the gallbladder from above downward by sharp dissection is commenced.

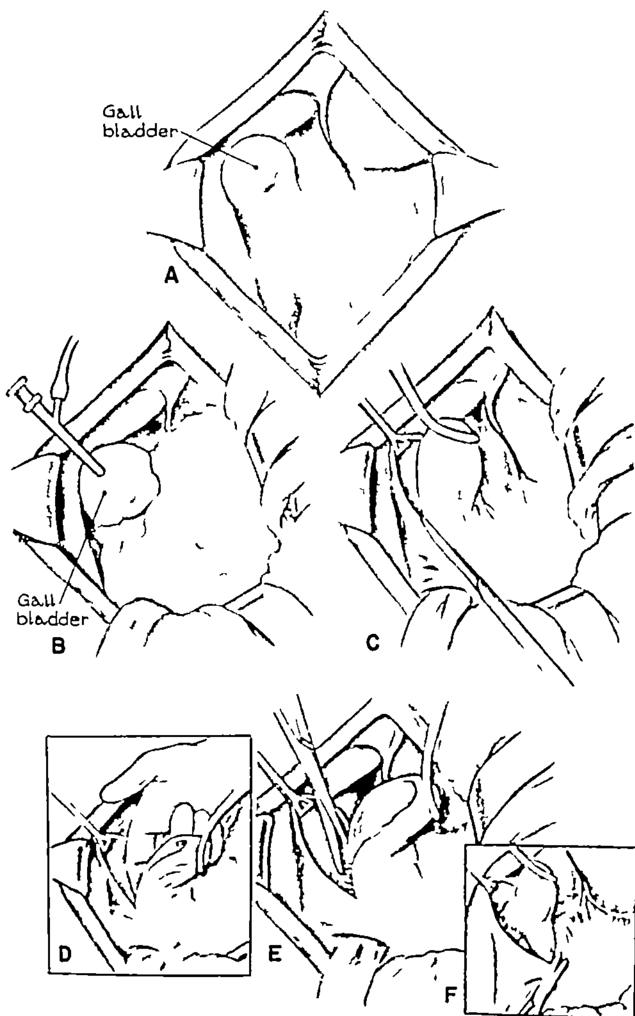
D E. The detachment of the gallbladder from its bed is continued by blunt digital and scissor dissection.

F The scissor dissection is continued anteriorly in the edematous cholecystoduodenal ligament to expose the underlying cystic duct and artery

Discussion—Dr Glenn (cont.)

Cholecystectomy for acute cholecystitis (Plates, 191 192) may be embarked upon with safety if after decompression of the distended inflamed viscus one can identify the cystic duct and cystic artery If one removes a gallbladder from the fundus downward without temporarily occluding the cystic artery bleeding may be considerable. If the cystic duct is not identified, cholecystectomy is hazardous because of the danger of injury to the common duct. These factors, together with others, require evaluation in arriving at a decision as to whether to do a cholecystectomy or a cholecystostomy for acute cholecystitis.

Drainage following cholecystectomy (Plate 192, J) has been demonstrated to be an essential step in making it a safer procedure. Drains should be placed so that they provide the most direct route. A generous stab wound that permits the drain to reach the exterior and not pass through the abdominal wound is desirable. The incidence of postoperative hernia is greater in abdominal wounds through which drains are placed Care is to be exercised to see that a drain from the operative area does not protrude into the lesser peritoneal sac through the foramen of Winslow This may result in a lesser sac abscess.


Gall bladder
A
Gall bladder
B
C
D
E
F

G The mobilization of the gallbladder from its liver bed is completed. The only attachments remaining are the cystic duct and cystic artery

H. The cystic artery because of its shorter length, is the first to be doubly clamped, severed, and occluded proximally with a ligature and a transfixion suture of silk (000)

I. In like manner the cystic duct is clamped, divided, and ligated, and the gallbladder is removed.

J A drain is inserted routinely into the foramen of Winslow and has its exit through the wound. The open liver bed is preferred to the peritonization method previously illustrated.

K. Layer closure of the wound using interrupted sutures of silk (00) for both the peritoneum and fascia. In the closure of a paramedian incision, the rectus muscle serves as a protective barrier between the lines of closure in the peritoneal and fascial layers.

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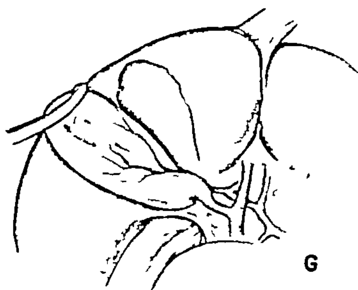
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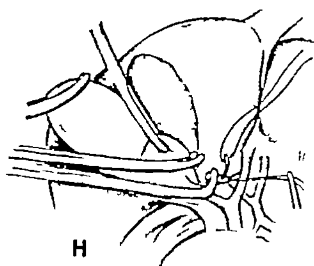
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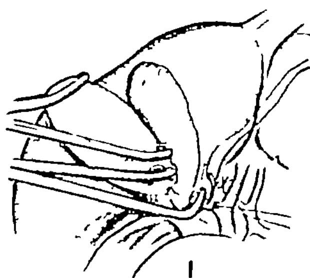
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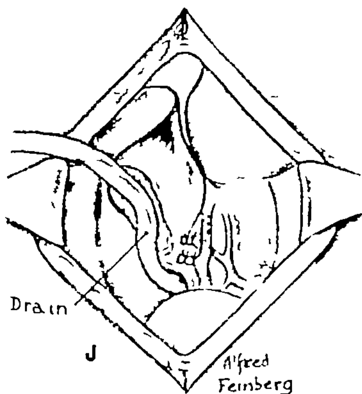
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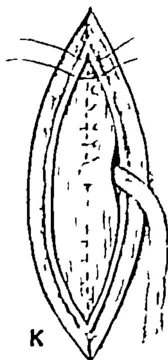
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G


H


I


Drain
J
Alfred
Feinberg


K

COMMON DUCT EXPLORATION

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A. In all secondary explorations and frequently in primary explorations of the common duct, the hepatic flexure is mobilized by severance of the right phrenocolic ligament, as depicted in dotted outline.

B. The mobilized hepatic flexure and the proximal portion of the transverse colon are displaced downward, and scissor dissection of the cholecystoduodenal ligament is commenced. The curved dotted line indicates the line of incision (Kocher) in the posterior parietal peritoneum for the mobilization of the retrocolic portion of the duodenum.

C. By blunt digital dissection in the retroperitoneal tissue plane, the duodenum and the head of the pancreas are mobilized and rotated toward the midline.

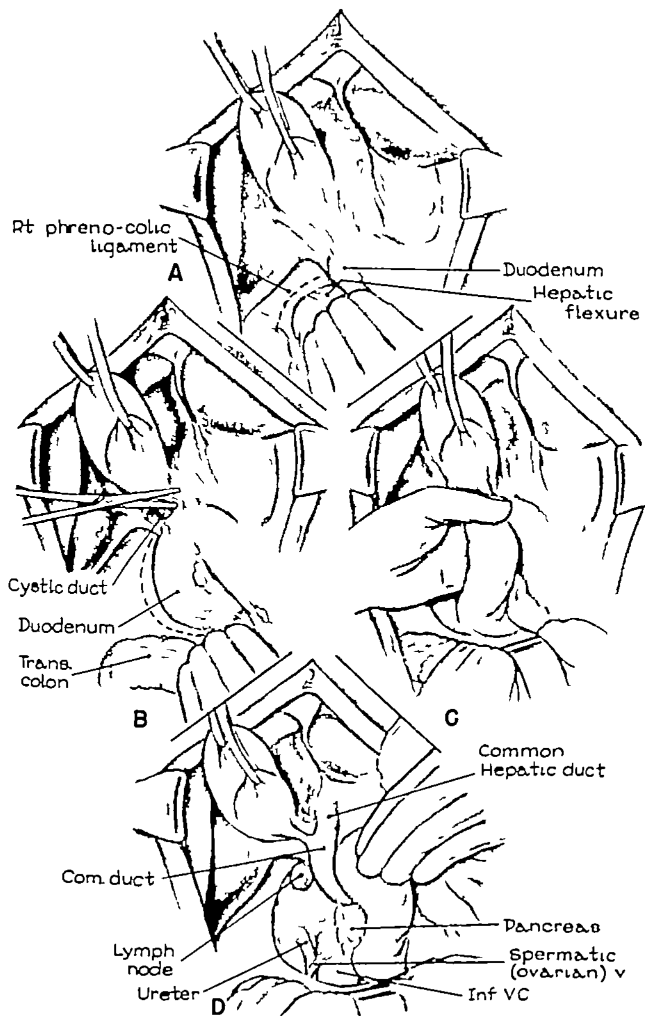
D. The mobilization of the second portion of the duodenum is completed to expose the retroduodenal portion of the common duct and its related structures. The lymph node laterally and the gastroduodenal artery medially are excellent landmarks for the identification of the distal portion of the common duct.

DISCUSSION—DR. GLENN (cont.)

In exploration of the common duct (Plates 193 194), mobilization of the duodenum (Plate 193 B C, D) *enables one to examine the course of the common duct from the cystic duct to its entrance into the duodenal wall.* There is considerable variation in the anatomic relationship of the duodenum, ascending colon, and subhepatic structures. Thus it is sometimes of advantage to make an incision through the peritoneum from the area of the junction of the duodenum and common duct laterally and downward to enable one to reflect the colon and duodenum. It is a very useful maneuver in secondary operations where identification of the common duct, portal vein, and hepatic artery may be difficult. This approach requires a very generous abdominal incision.

An adequate common duct exploration is one that leaves no stones behind and demonstrates any cause of obstruction, if present. Linear incisions in the common duct equal or greater than its diameter afford the needed portal of exploration. Instruments that are used to detect stones including bougies, probes, catheters, and pituitary spoons have special merit according to the dexterity and experience of those who use them. *A conviction that the ductal* system being explored contains a stone or stones is a great stimulus and determines to a considerable degree the care and thoroughness with which the procedure is accomplished.

Following choledochotomy the common duct may be drained by one of two ways. The first is to place a catheter through the cystic duct remnant and close the wall of the common duct. The second is to employ a T-tube and bring it out through the proximal end of the choledochotomy wound. In either event a water-tight closure of the common duct is to be done. Leakage results in periductal accumulations. Interrupted sutures of 00000 silk or 000 catgut enable one to attain such a closure. Careful testing of the integrity of the closure by injection of saline into the tube while temporarily compressing the duct above and below is an important step.


Rt phreno-colic ligament
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Duodenum
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Spermatic (ovarian) v
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C. By blunt digital dissection in the retroperitoneal tissue plane the duodenum and the head of the pancreas are mobilized and rotated toward the midline.

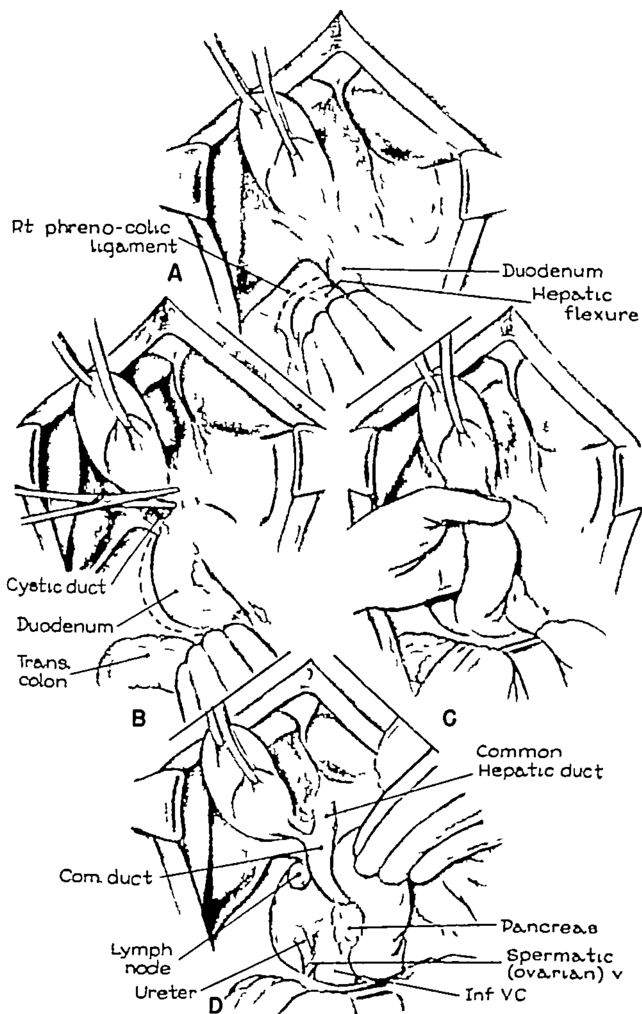
D The mobilization of the second portion of the duodenum is completed to expose the retroduodenal portion of the common duct and its related structures. The lymph node laterally and the gastroduodenal artery medially are excellent landmarks for the identification of the distal portion of the common duct.

DISCUSSION—DR. GLENN (cont)

In exploration of the common duct (Plates 193 194), mobilization of the duodenum (Plate 193, B C, D) enables one to examine the course of the common duct from the cystic duct to its entrance into the duodenal wall. There is considerable variation in the anatomic relationship of the duodenum, ascending colon, and subhepatic structures Thus it is sometimes of advantage to make an incision through the peritoneum from the area of the junction of the duodenum and common duct laterally and downward to enable one to reflect the colon and duodenum. It is a very useful maneuver in secondary operations where identification of the common duct, portal vein, and hepatic artery may be difficult. This approach requires a very generous abdominal incision.

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C. By blunt digital dissection in the retroperitoneal tissue plane, the duodenum and the head of the pancreas are mobilized and rotated toward the midline.

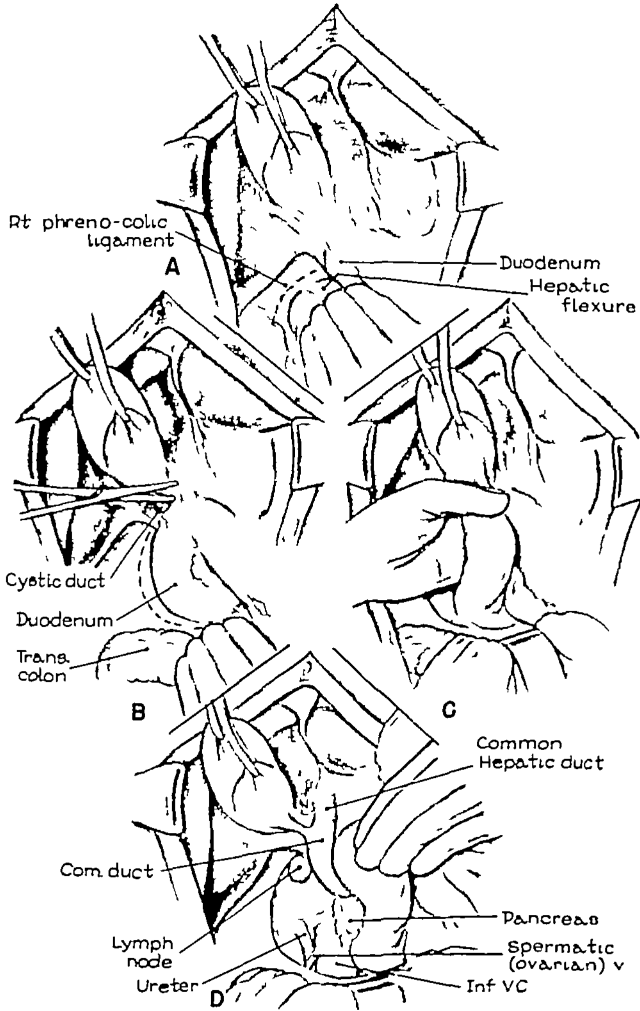
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Discussion—Dr Glenn (cont.)

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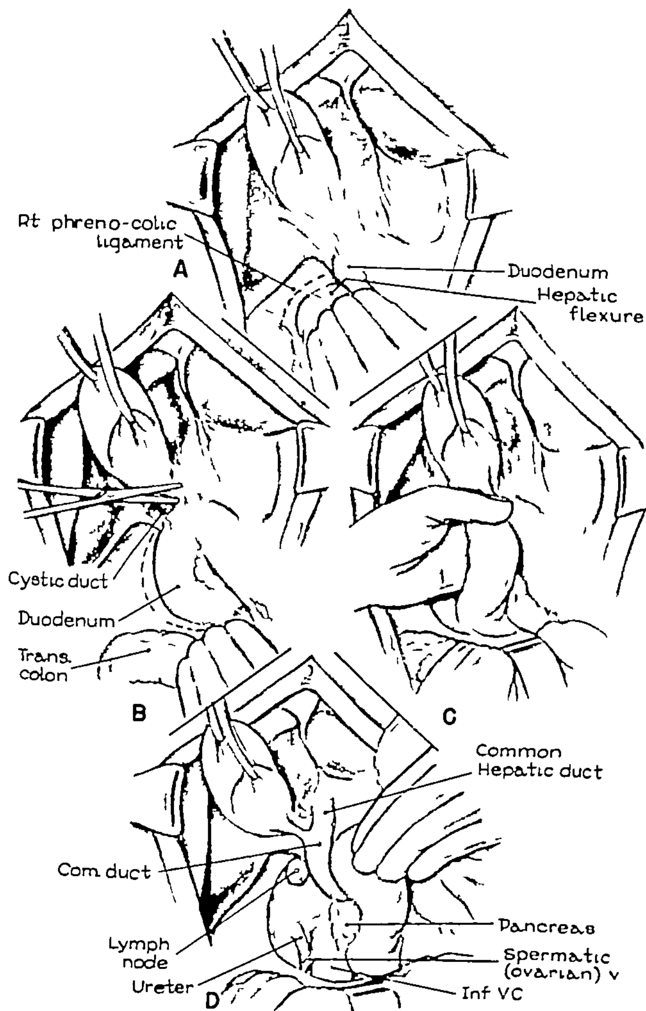
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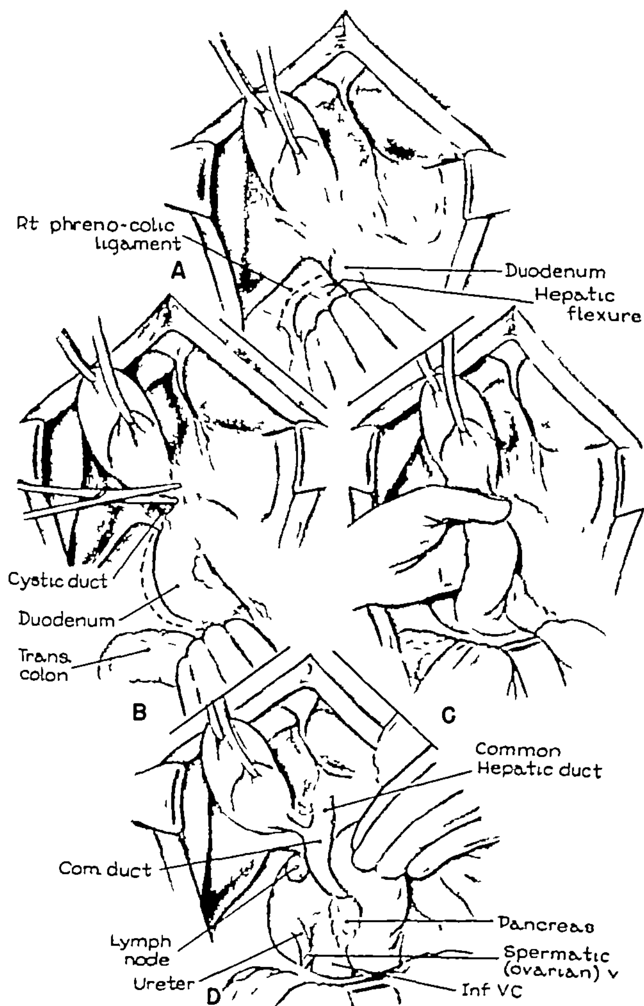
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In exploration of the common duct (Plates 193 194), mobilization of the duodenum (Plate 193 B, C, D) enables one to examine the course of the common duct from the cystic duct to its entrance into the duodenal wall. There is considerable variation in the anatomic relationship of the duodenum, ascending colon, and subhepatic structures. Thus it is sometimes of advantage to make an incision through the peritoneum from the area of the junction of the duodenum and common duct laterally and downward to enable one to reflect the colon and duodenum. It is a very useful maneuver in secondary operations where identification of the common duct, portal vein, and hepatic artery may be difficult. This approach requires a very generous abdominal incision.

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E. In explorations of the common duct, the gallbladder because it serves as a technical expediency is not removed until the exploration is completed. However prior to exploration, the terminal portion of the cystic duct is occluded with a ligature of silk to prevent egress of stones from the gallbladder into the common duct. The incision in the anterior wall of the duct between guy sutures of silk (00000) is shown in dotted outline. The location of the terminal portion of the common duct, between the lymph node laterally and the gastroduodenal artery medially is visible.

E′ A new set of guy sutures is inserted through the incised margins of the common duct, and the guy sutures in the wall of the duct are removed.

F The lumen of the dilated common duct is explored distally with a small scoop, and a stone present is removed.

G Digital palpation along the outside wall of the common duct against an indwelling probe is performed. This maneuver is a technical aid in the detection of small stones which may be felt to grate against the probe.

H The exploration of the common duct is continued with the use of a Bakes dilator (4 mm.) If possible, the dilator is inserted through the papilla of Vater into the duodenum. If successful, progressively larger dilators are used up to one of 8 mm. in size In using the dilators, one must avoid undue trauma and the establishment of false passages

I. A soft rubber catheter (No 12 F) is inserted into the duct and irrigation of its lumen with copious quantities of warm saline solution is performed. This procedure is considered one of the best methods for the removal of occult stones.

J *A two-holed rubber catheter (No 12 F)* is inserted into the lumen of the common duct and directed toward the liver This size catheter is used regardless of the degree of dilatation of the common duct and is removed routinely on the fourth postoperative day if the cholangiogram taken at this time is negative. Catheter drainage of the common duct is preferred to the use of a T tube.

K. The operative field after the completion of the exploration of the common duct, the establishment of a catheter choledochostomy and cholecystectomy

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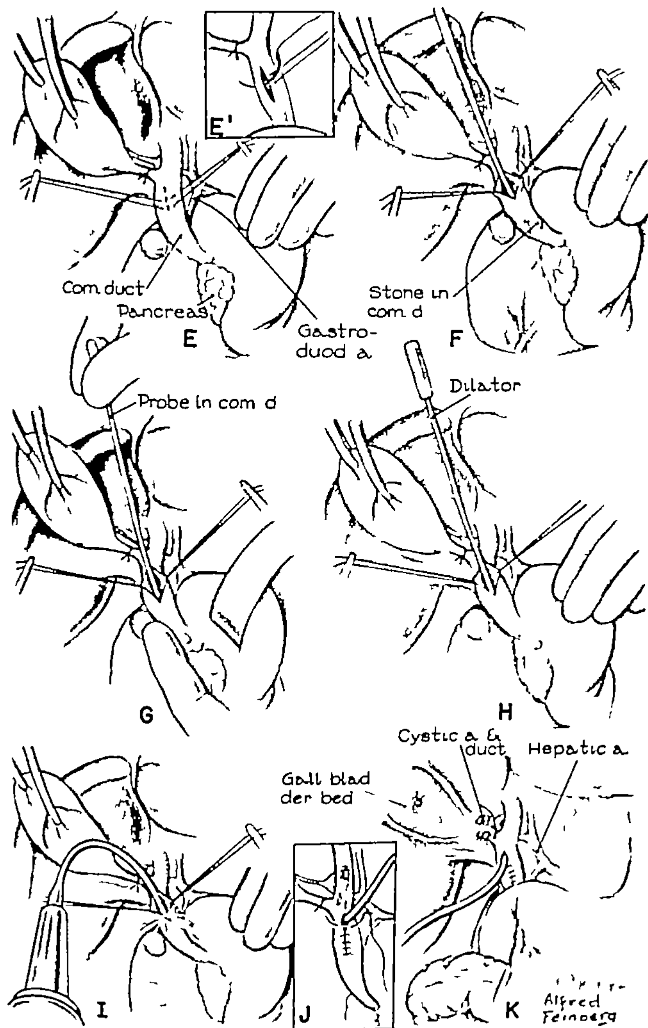
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E'
Com. duct
Pancreas
E
Gastro-
duod a.
Stone in
com. d
F
Probe in com d
Dilator
G
H
Cystic a. &
duct
Hepatic a.
Gall blad
der bed
I
J
K
Alfred
Feinberg

CHOLECYSTOJEJUNOSTOMY

A. The peritoneal cavity is entered, and the distended gallbladder in relation to its surrounding structures, is visible

B C. A trocar and canula are inserted into the lumen of the gallbladder (B) and the trocar is withdrawn to decompress the gallbladder by suction siphonage (C) Only after the gallbladder is decompressed (C) are the clamps (Babcock) applied.

D E. The transverse colon is elevated, and an opening is made by blunt dissection in a relatively avascular plane of the transverse mesocolon (D). Through this opening a loop of jejunum secured by traction guy sutures of silk (000) is withdrawn (E).

E_1 If preferred, the jejunum may be brought in front (antecolic) of rather than behind (retrocolic) the colon.

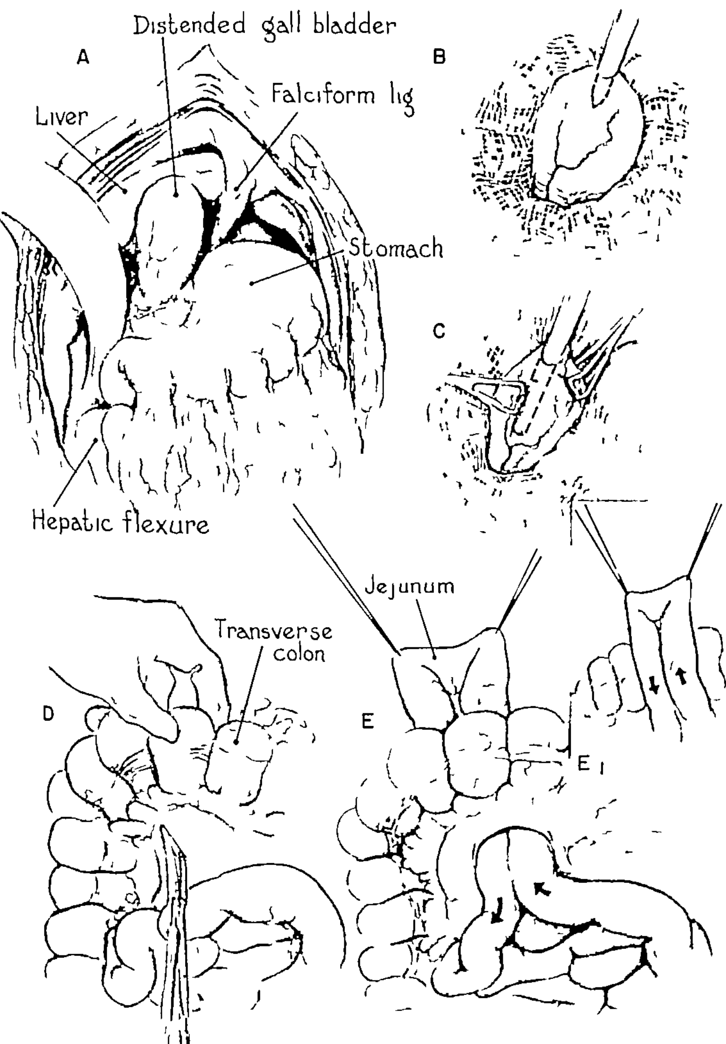
DISCUSSION—DR. RALPH COLP Patients with severe obstructive jaundice in whom palliative procedures are indicated are those with inoperable carcinomatous infiltration either of the head of the pancreas, of the duodenum, or of the terminal portion of the common duct, and occasionally those with advanced chronic pancreatitis. In these pathologic conditions, the distal area of the choledochus is either infiltrated by tumor or compressed by scar tissue formation or neoplasm. Regardless of the preoperative diagnosis, exploration is indicated unless hepatic metastases are definitely palpable, ascites is present, or rectal examination reveals the presence of a Blumer's shelf.

Preoperatively these patients should be prepared by a high carbohydrate and protein diet, vitamin K, blood transfusions, and the correction of electrolytic imbalances. In the performance of the operation, spinal anesthesia is preferred. An upper oblique right rectus muscle-splitting incision usually provides adequate exposure. Exploration in most cases reveals a dilated gallbladder and a dilatation of the common bile duct If the cause of the obstruction cannot be removed, the jaundice may be relieved by a side tracking biliary-intestinal anastomosis.

The choice of operation depends upon the surgeon's preference and his judgment. Prior to any type of anastomosis, the large gallbladder is carefully isolated by abdominal pads. A 1 inch incision is made through the serosa of the gallbladder parallel to, and at least 1 inch from the liver margin. A trocar is introduced into its lumen and the thick viscid bile is aspirated. The original serosal incision is now deepened through all the walls of the gallbladder and its interior is palpated for the presence of biliary calculi. The thin gallbladder should be handled with care. Any type of grasping clamp used should be loosely applied. This may be dispensed with if guy sutures of silk are used for traction. The gallbladder may now be anastomosed either to the stomach, duodenum, or jejunum. The basic technics illustrated by the author are applicable, with minor variations, to all types of anastomoses.

Our own preference is a cholecystogastrostomy This not only presents fewer technical difficulties, but is followed by a negligible mortality and an insignificant morbidity If the jejunum is used, many prefer the Roux-en Y method of cholecystojejunostomy This procedure is time consuming and entails certain operative hazards. In its performance the mesentery of the jejunum is partially divided about 24 inches from the ligament of Treitz. The bowel is then transected between Von Petz clips or rubber covered intestinal clamps. The distal end of the jejunum is anastomosed to the gallbladder and intestinal continuity is restored by implanting its proximal end into the distal limb either by an end-to-side or a side-to-side jejunojejunostomy This anastomosis is made about 18 inches below the site of the cholecystojejunostomy Following a side-to-side cholecystojejunostomy some surgeons elect to perform a complementary jejunojejunostomy about 12 inches from the anastomosis.

There are theoretic reasons for the Roux-en-Y anastomosis or the addition of a complementary jejunojejunostomy It is believed that the danger of an ascending infection from a reflux of jejunal contents into the ducts of the liver via the gallbladder is minimized by either one of these two methods.


Distended gall bladder
A
B
Falciform lig
Liver
Stomach
C
Hepatic flexure
Jejunum
Transverse colon
D
E
E 1

F. Guy sutures of silk (000) are inserted at either angle of the enlarged opening in the gallbladder and the first posterior layer of sutures (000 silk) to approximate the gall bladder and jejunum is inserted, but the sutures are not tied.

G. H. An incision is made through the seromuscular layer of the jejunum (G) to expose the vessels in the submucosa. These vessels are undersewn with hemostatic suture ligatures of 000 silk (H).

I. J. An opening is made into the lumen of the jejunum between the two rows of hemostatic suture ligatures (I) and then enlarged by scissor dissection (J).

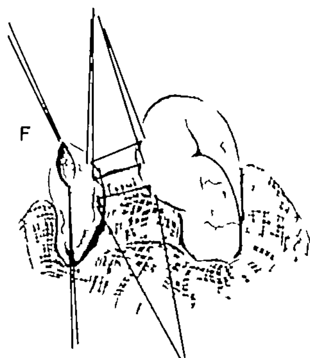
K. Upon completion of the opening in the jejunum, the sutures of the first posterior layer are tied, and the insertion of the second posterior layer a series of interrupted sutures (0000 silk) which includes all of the layers of the jejunum and gallbladder is begun.

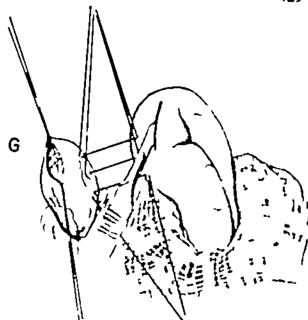
Discussion—Dr. Colp (cont.)

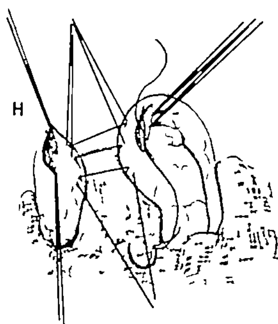
Ascending infection is a potential hazard in any type of biliary intestinal anastomosis. However it is not dependent upon the reflux alone. It is more dependent upon biliary stasis with infection secondary to a stenosis of the anastomotic stoma. This unfortunate complication may be lessened by making the primary anastomosis sufficiently large and approximating the mucosa of the gallbladder most carefully to the mucosa of the stomach, duodenum, or jejunum. These precautions will result in an adequate stoma with a minimum of scar tissue formation. However most patients die from metastatic carcinoma before ascending infection ever becomes a serious threat to life. Minor episodes of concurrent infection usually can be controlled by the use of appropriate antibiotics.

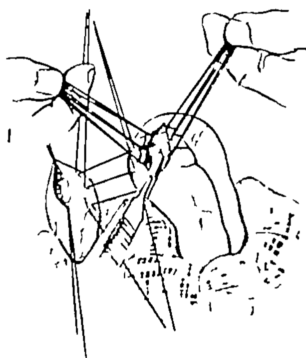
In some instances, the gallbladder is either contracted because of disease or absent because of previous cholecystectomy. Under such circumstances, the dilated common duct must be carefully explored. If necessary an anterior duodenotomy is indicated to eliminate the possibility of an impacted ampullary calculus. If exploration discloses that the obstruction is due to an inoperable carcinoma, the dilated duct may be anastomosed either to the duodenum or the jejunum. The duodenum is mobilized by incising the peritoneum along its lateral border and the side of the dilated duct is anastomosed to the lateral wall of the duodenum. If mobilization of the duodenum is impractical, a transverse incision is made into its first portion in close proximity to the common duct, and an end-to-side choledochoduodenostomy is performed. If the duodenum, because of carcinomatous infiltration, is unsuitable for an anastomosis, the choledochus and the jejunum may be joined by a Roux-en-Y choledochojejunostomy. If either of these operations is performed, it may be safer to do a complementary biliary intestinal intubation. The technic is simple. After the posterior double row of sutures has been placed, a fenestrated rubber tube is introduced into the proximal choledochus so that it fits rather snugly. The distal end of the tube is then inserted into the duodenum or jejunum for about 8 inches. The two anterior layers of the anastomosis are now completed. The tube not only insures the immediate flow of bile from the liver to the intestines, but it acts as a supporting scaffold and prevents obstructive edema of the stoma. Before discharge, patients should always be apprized of the fact that a rubber tube has been left in situ, but that it will eventually be passed per rectum.

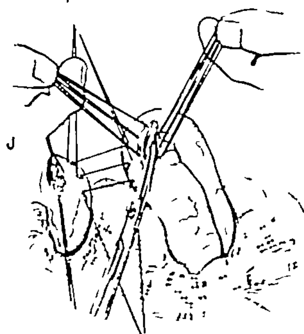
Following any type of palliative diverting procedure, intraabdominal drainage of the abdomen is unnecessary. The anterior abdominal wall should be closed in layers and reinforced with through and through sutures. In jaundiced patients with carcinoma the tissues heal slowly and poorly. Accordingly wound dehiscence and evisceration are not infrequent complications. Postoperatively gastric suction should be maintained until normal gastrointestinal peristalsis occurs. During this period, the electrolyte and fluid balances should be maintained by intravenous solutions.

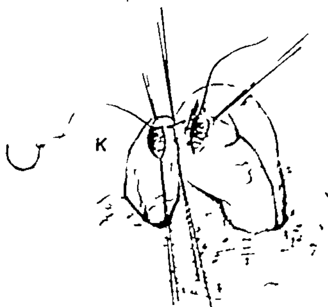

F


G


H


I


J


K

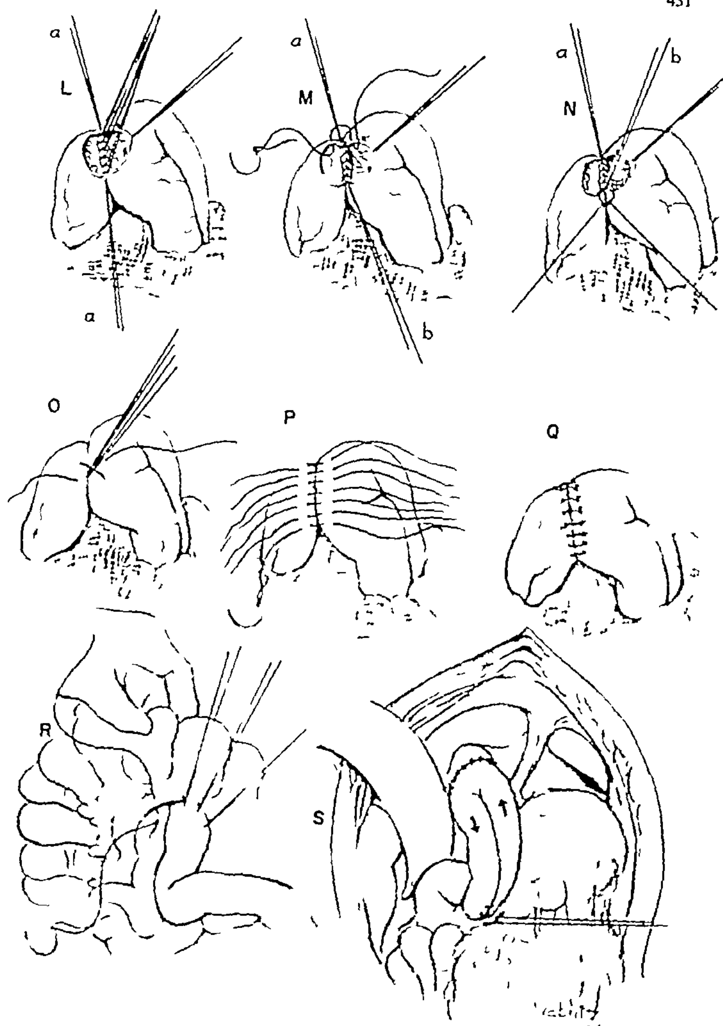
L, M N O The sutures of the second posterior layer are inserted and tied (L) The long strands of the sutures are cut, and the insertion of the first anterior inverting layer of sutures (000 silk) is begun (M) These sutures are inserted from the "inside out" on one side and from the "outside in" on the other so that, when tied, the knots of the sutures are on the inside of the lumen. To facilitate the inversion of the tissue layers, traction on the previously inserted suture is maintained in the long axis of the anastomosis as each succeeding suture is tied. The sutures are inserted alternately from either angle (M, N) toward the center where the termination of the last two sutures is encircled by a figure of 8 mattress suture before the long strands are cut (O).

P Q The figure of 8 mattress suture is tied and cut, and the second anterior layer of sutures (Lembert) is first inserted (P) and then tied and cut (Q)

R, S. Following completion of the cholecystojejunostomy the margins of the opening on the inferior surface of the transverse mesocolon are anchored to the afferent and efferent loops of the jejunum (R) On the superior aspect of the transverse colon a similar anchoring suture of the mattress type is inserted (S) These sutures serve to obliterate any opening through which herniation of additional small bowel loops may occur If desired, an enteroenterostomy may be performed between the afferent and efferent loops proximal to the site of the cholecystojejunostomy

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L
a
a
M
a
b
N
a
b
O
P
Q
R
S

SPHINCTEROTOMY

A, B, C. The scar of the previous operation (cholecystectomy) is elliptically excised (dotted lines) (A), and the peritoneal cavity is entered through a muscle-splitting incision (B). The postoperative intraperitoneal adhesions between the liver and colon are readily visible (C).

D The colon is freed from the liver and the hepatic flexure is mobilized by the severance of the right phrenocolic ligament as indicated by the dotted line.

E. The hepatic flexure is displaced downward toward the left lower quadrant of the abdomen, and the lateral incision for the mobilization of the duodenum (Kocher) is shown in dotted outline.

F The mobilized duodenum is rotated and displaced toward the midline (Moynihan rotation maneuver), and the site of the transverse incision in the common duct (dotted line) and the adjacent related structures are visible.

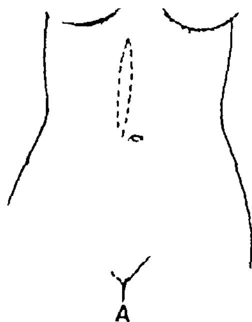
G If desired, a longitudinal incision in the common duct which is elongated transversely by traction guy sutures of silk (00000) may be used in preference to the transverse incision.

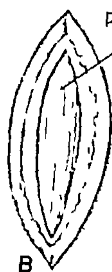
Discussion—Drs I. S. Ravdin and Gerald W. Peskin Sphincterotomy is practiced for the removal of stones impacted in the distal common bile duct and to relieve recurrent attacks of pancreatitis. Although the incision for this operation may be made through the scar of a previous rectus incision, a new subcostal approach is often used to obtain better exposure and wound healing, particularly in the patient with a wide costal angle. When the rectus incision is elected, it is wise to attempt lateral retraction rather than splitting of this muscle in order to conserve nervous innervation. When the posterior rectus sheath and peritoneum are incised elevating the anterior rectus fascia with a series of Kocher hemostats decreases the likelihood of entering a viscus rather than the free peritoneal cavity

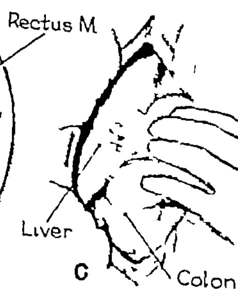
Once inside the abdomen, the first step is to clear the subhepatic area of organs adherent to the liver By staying close to the liver edge and using sharp dissection, the attached hepatic flexure of the colon and displaced duodenum are quickly freed Mobilization of the lateral aspect of the duodenum is completed by the Kocher maneuver as depicted in Plate 198, E, and the pancreas is manually examined for pseudocysts and abscesses. The common duct is approached from the lateral free edge of tissue representing the duodenohepatic ligament, using the pulsation of the hepatic artery as the medial guide. The blue green color of the duct is invaluable in its identification. When doubt exists as to the exact location of the duct, a hypodermic needle attached to a small syringe is used to probe the general area in search of bile. This maneuver is of great help in avoiding accidental injury to the portal vein or hepatic artery It is unnecessary and even hazardous to attempt the wide clearing of structures depicted in Plate 198 F

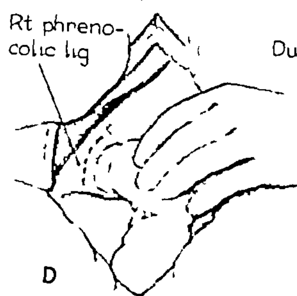
Following the placement of two guide sutures of 000 chromic catgut (atraumatic), a longitudinal incision is made in the common duct about 1 inch above the superior edge of the duodenum or if the gallbladder is present, just distal to the junction of the cystic duct with the common duct. Again it is a wise practice to aspirate the structure thought to be the common duct before incising it. The common duct is then probed and irrigated to remove any residual debris.

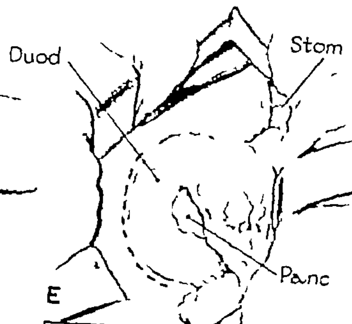
When a Bakes dilator cannot be made to traverse the sphincter or when the primary intent of operation is sphincterotomy the area around the duodenal loop is carefully walled off with sponges to minimize soilage upon opening the duodenum. With the dilator in the distal common duct as a guide, a 2 inch vertical incision is made in the anterolateral wall of the duodenum and centered over the tip of the probe. After ligating small subserosal bleeding points, Babcock clamps are placed to retract the cut margins of the duodenum. A small, tagged tape is then inserted into the proximal duodenal lumen to prevent gastric and duodenal secretions from obscuring the area of the papilla The papilla is thrown into prominence by gentle pressure on the dilator within the common duct If the ductal orifice is still not apparent with this maneuver 1 or 2 ml. of methylene blue can be instilled into the common duct, and its appearance in the duodenum within a few moments will pinpoint the papillary ostium. Incision of the papilla is performed in a manner similar to that depicted in Plate 199 L, employing 1 cm. as the safe distance for obtaining an adequate aperture without risking perforation of the duodenum. Dilators are passed upward and downward through the enlarged sphincter until adequate patency is assured Because of occasional hemorrhage from this site in the past, we have found

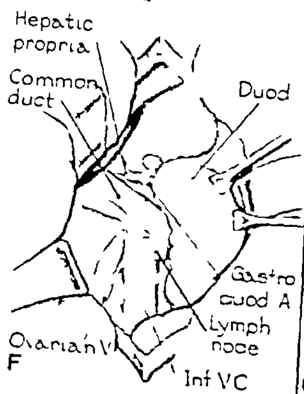

A

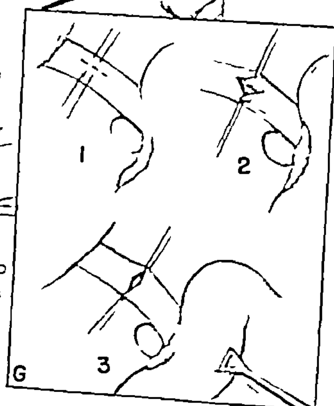

Rectus M
B


Liver
C
Colon


Rt phreno-
colic lig
D


Duod
Stom
Panc
E


Hepatic
propria
Common
duct
Duod
Gastro
duod A
Lymph
node
Ovarian V
Inf VC
F


1
2
3
G

H A probe is inserted through the incision in the common duct into its lumen. However the probe could not be passed through the papilla of Vater into the duodenum. When this occurs, it is imperative for the surgeon to determine the presence or absence of an obstruction in the region of the papilla of Vater Accordingly a duodenotomy is advised, and, in the absence of a tumor or calculus as a cause of the obstruction, either a sphincterotomy or a choledochoduodenostomy is recommended. Under such circumstances a choledochoduodenostomy is frequently preferred.

I The lumen of the common duct is irrigated thoroughly and frequently occult calculi will be flushed out.

J An incision is made through the seromuscular coat of the posterior wall of the duodenum overlying the region of the papilla, and the vessels in the submucosal layer are undersewn with hemostatic suture ligatures.

J[1] Inset showing the incision into the lumen of the duodenum being made by scissor dissection between the two rows of hemostatic sutures.

K. The cut margins of the duodenum are retracted in Babcock clamps, and the probe in the common duct is held firmly against the papilla to project it more prominently into the lumen of the duodenum.

L, L[1] The mucosa of the duodenum overlying the probe is incised with a scalpel (L), and the probe is then readily passed into the lumen of the duodenum (L[1]).

DISCUSSION—DRS. RAVDIN AND PESKIN (cont.)

it valuable to tack the cut edge of the common duct wall to the cut edge of the duodenal wall with several sutures of 00000 atraumatic chromic catgut. Not only does this provide hemostasis, but it serves to prevent stricture of the sphincterotomy site Care must be taken, in placing these sutures, not to encroach upon the pancreatic duct opening. This may be probed if serious doubt exists as to its location. A roentgenographic evaluation of the pancreatic duct may be obtained at this point by placing a fine polyethylene catheter into the duct of Wirsung through the sphincterotomy opening and injecting a radiopaque material If the pancreatic duct appears obstructed on the roentgenograms, distal pancreaticojejunostomy must be seriously considered

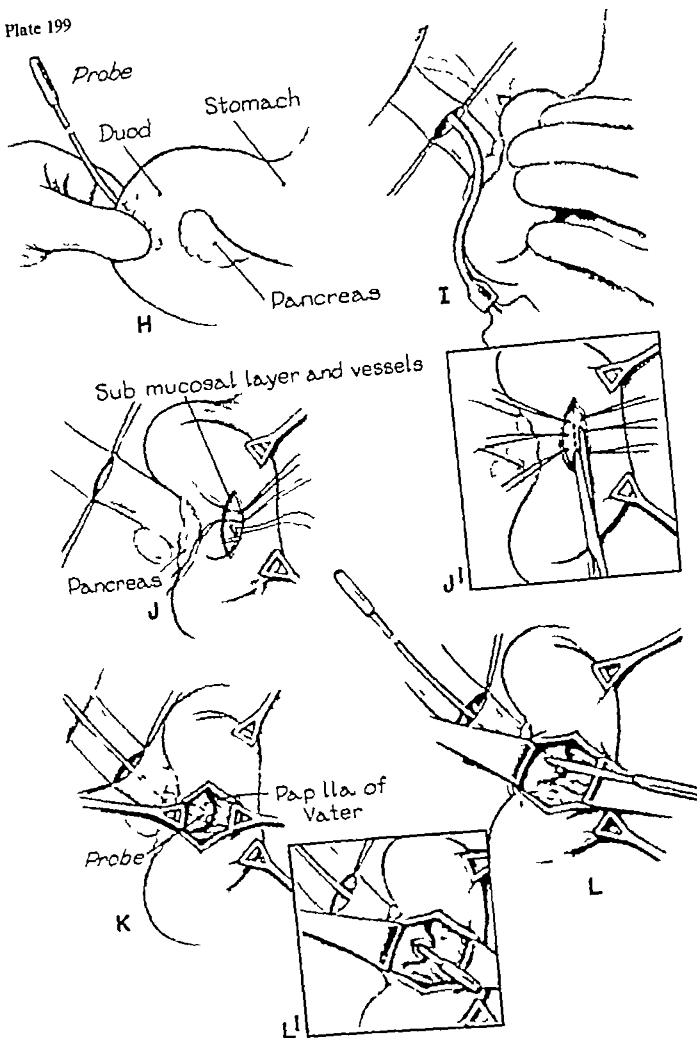
Transverse closure of the duodenotomy is accomplished after removal of the pack within the duodenal lumen employing O chromic catgut (atraumatic) for the first layer and beginning at each lateral margin of the incision. A running, inverting, Connell-type stitch is utilized, catch... imal amount of tissue with each bite Th... tied at the center of the incision. Interru... ular Lembert sutures of 000 silk are use... the closure after gloves and drapes have been changed. A tag of omentum may be fastened over the duodenal wound when available.

In contrast to the technic employed in Plate 200, O we prefer to employ the largest rubber T tube which will comfortably fit within the common duct (usually No 18 or No. 16 French). Water-tight closure of the duct is accomplished in a longitudinal fashion with interrupted sutures of 000 chromic catgut (atraumatic).

A sump drain is routinely placed just lateral to the junction of the duodenum and common duct, and it and the T tube are led out of the peritoneal cavity through separate stab wounds in the flank. This provides ... ndent drainage, does not weaken the wou... es accidental removal of the drain or T ... dressing changes less likely Abdom... losure is performed in l... 8 stainless steel wire f... nor...

It ... important to remov... der... t the time of sph... avoi... sequelae which ma... organ.

Plate 199


Probe
Stomach
Duod
Pancreas
H
I
Sub mucosal layer and vessels
Pancreas
J
J¹
Pap lla of Vater
Probe
K
L
L¹

H A probe is inserted through the incision in the common duct into its lumen. However the probe could not be passed through the papilla of Vater into the duodenum. When this occurs, it is imperative for the surgeon to determine the presence or absence of an obstruction in the region of the papilla of Vater Accordingly a duodenotomy is advised, and, in the absence of a tumor or calculus as a cause of the obstruction, either a sphincterotomy or a choledochoduodenostomy is recommended. Under such circumstances a choledochoduodenostomy is frequently preferred.

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J[1] Inset showing the incision into the lumen of the duodenum being made by scissor dissection between the two rows of hemostatic sutures.

K. The cut margins of the duodenum are retracted in Babcock clamps, and the probe in the common duct is held firmly against the papilla to project it more prominently into the lumen of the duodenum.

L, L[1] The mucosa of the duodenum overlying the probe is incised with a scalpel (L) and the probe is then readily passed into the lumen of the duodenum (L[1])

Discussion—Drs. Ravdin and Peskin (cont.)

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In contrast to the technic employed in Plate 200, O we prefer to employ the largest rubber T tube which will comfortably fit within the common duct (usually No 18 or No 16 French). Water-tight closure of the duct is accomplished in a longitudinal fashion with interrupted sutures of 000 chromic catgut (atraumatic).

A sump drain is routinely placed just lateral to the junction of the duodenum and common duct, and it and the T tube are led out of the peritoneal cavity through separate stab wounds in the flank. This provides more dependent drainage, does not weaken the wound, and makes accidental removal of the drain or T-tube during dressing changes less likely Abdominal wound closure is performed in layers using interrupted No. 28 stainless steel wire for the anterior rectus fascia.

It is extremely important to remove the gallbladder if present, at the time of sphincterotomy to avoid the serious sequelae which may result from malfunction of this organ.

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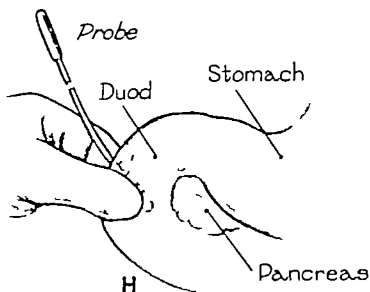
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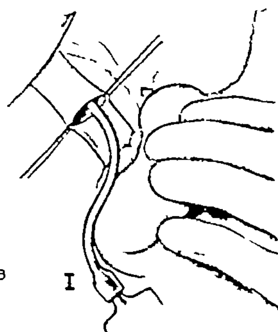
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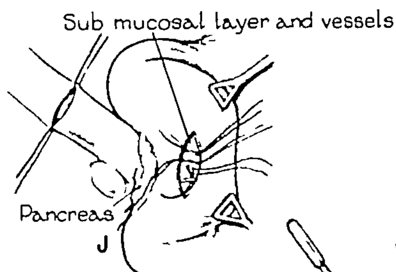
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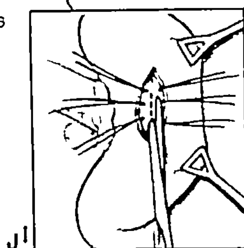
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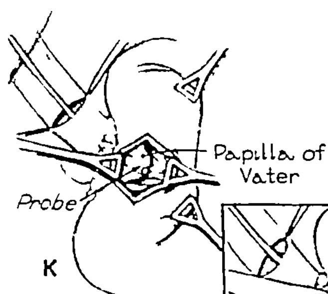
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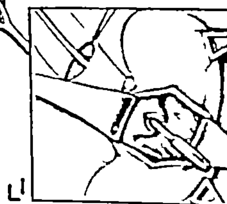

Probe
Stomach
Duod
Pancreas
H

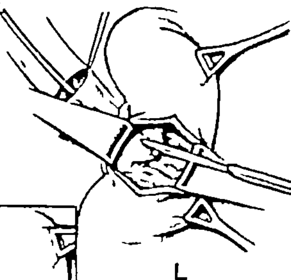

I


Sub mucosal layer and vessels
Pancreas
J


J[1]


Papilla of
Vater
Probe
K


L[1]


L

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DISCUSSION—DRS. RAVDIN AND PESKIN (cont.)

it valuable to tack the cut edge of the common duct wall to the cut edge of the duodenal wall with several sutures of 00000 atraumatic chromic catgut. Not only does this provide hemostasis, but it serves to prevent stricture of the sphincterotomy site. Care must be taken, in placing these sutures, not to encroach upon the pancreatic duct opening. This may be probed if serious doubt exists as to its location. A roentgenographic evaluation of the pancreatic duct may be obtained at this point by placing a fine polyethylene catheter into the duct of Wirsung through the sphincterotomy opening and injecting a radiopaque material. If the pancreatic duct appears obstructed on the roentgenograms, distal pancreaticojejunostomy must be seriously considered.

Transverse closure of the duodenotomy is accomplished after removal of the pack within the duodenal lumen employing O chromic catgut (atraumatic) for the first layer and beginning at each lateral margin of the incision. A running, inverting, Connell-type stitch is utilized, catching a minimal amount of tissue with each bite. The sutures are tied at the center of the incision. Interrupted seromuscular Lembert sutures of 000 silk are used to complete the closure after gloves and drapes have been changed. A tag of omentum may be fastened over the duodenal wound when available.

In contrast to the technic employed in Plate 200, O we prefer to employ the largest rubber T tube which will comfortably fit within the common duct (usually No 18 or No 16 French). Water tight closure of the duct is accomplished in a longitudinal fashion with interrupted sutures of 000 chromic catgut (atraumatic).

A sump drain is routinely placed just lateral to the junction of the duodenum and common duct, and it and the T tube are led out of the peritoneal cavity through separate stab wounds in the flank. This provides more dependent drainage, does not weaken the wound, and makes accidental removal of the drain or T tube during dressing changes less likely. Abdominal wound closure is performed in layers using interrupted No 28 stainless steel wire for the anterior rectus fascia.

It is extremely important to remove the gallbladder if present, at the time of sphincterotomy to avoid the serious sequelae which may result from malfunction of this organ.

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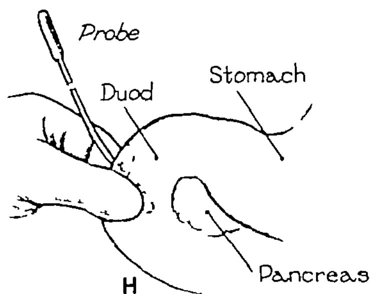
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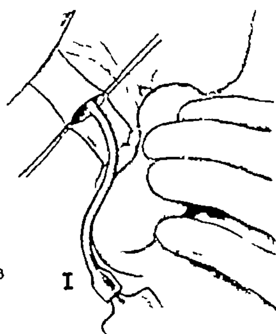
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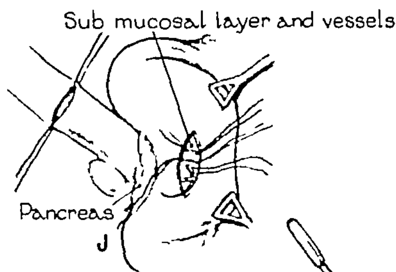
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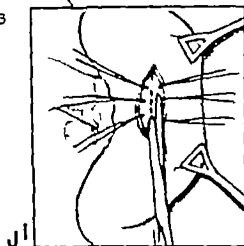
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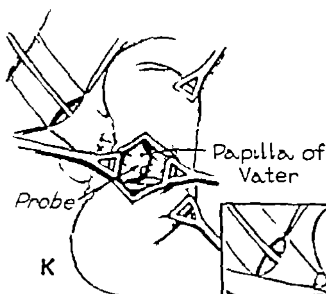
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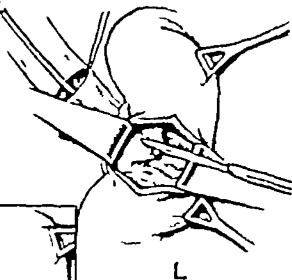

Probe
Stomach
Duod
Pancreas
H

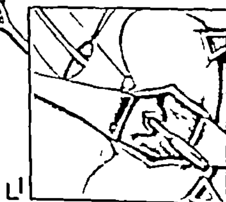

I


Sub mucosal layer and vessels
Pancreas
J


J¹


Papilla of
Vater
Probe
K


L


L¹

M. The probe is easily inserted in a retrograde manner through the incised sphincter into the lumen of the common duct and out through an opening in its anterior wall.

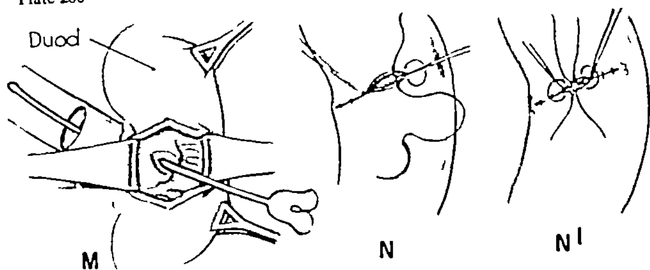
N N[1] N[2] N[3] N[4] The longitudinal opening in the duodenum is closed transversely in two layers using interrupted sutures of silk (000) The sutures forming the first layer are inserted alternately from either end and from the "inside out" to the "outside in" (N N) so that, when tied, the knots of the sutures are on the inside of the lumen. The site of the termination of the first layer of sutures in the center of the anastomosis is reinforced by an encircling figure of 8 suture (N[?]) and the second layer of interrupted seromuscular sutures is inserted (N[?] N).

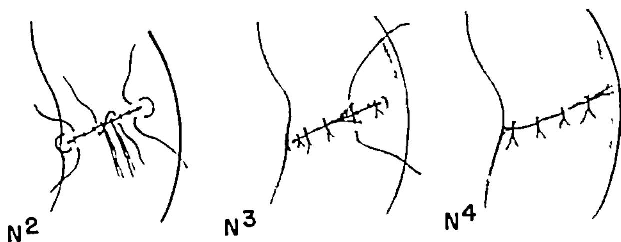
O The completed closure of the incisions in the common bile duct and the duodenum and their relation to the surrounding structures are visible.

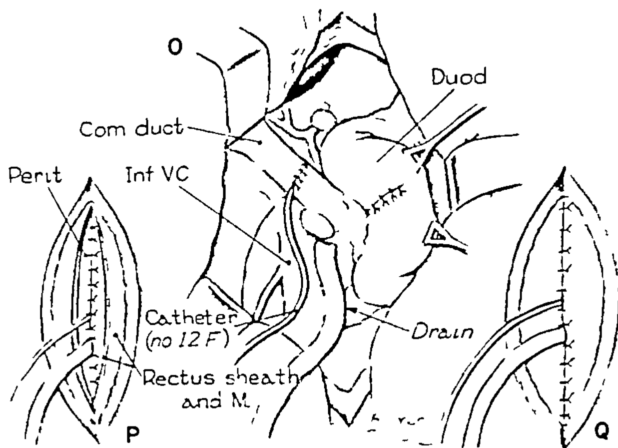
P Q The peritoneal (P) and fascial (Q) layers are closed about the peritoneal drain and the common duct catheter (No 12 F). Drainage through the incision is preferred to the use of stab wound drainage sites in the flank.

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Duod
M
N
N1


N2
N3
N4


O
Duod
Com duct
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Inf VC
Catheter
(no 12 F)
Drain
Rectus sheath
and M.
P
Q

The technic for exposure of the operative area is the same as that shown in the first plate of the illustrations for sphincterotomy and, accordingly is deleted here

A. The first posterior layer of interrupted silk (0000) sutures, which approximates the posterior aspect of the first portion of the duodenum to the side of the common bile duct, is shown being inserted. The dotted line indicates the site of the incision to be made in the duodenum.

B. The insertion of the first posterior layer of sutures which are not tied is completed. An incision has been made through the seromuscular layer of the duodenum, and the vessels in the submucosa are undersewn *with hemostatic sutures of 0000 silk.*

B^1 The first posterior layer of sutures is tied, and the second posterior layer of interrupted through and through silk (0000) sutures is being inserted.

B^2 B^3 B^4 The insertion of the second posterior layer of sutures is completed, and the first anterior layer is begun. This layer consists of interrupted silk sutures which are inserted from the "inside out" to the "out side in" so that when tied the knots are on the inside of the lumen (B B^4). These sutures meet in the center of the anastomosis anteriorly where a reinforcing figure of 8 suture ligature is inserted (B).

C. *The insertion of the second anterior layer* a series of interrupted mattress sutures of silk (0000), completes the operation.

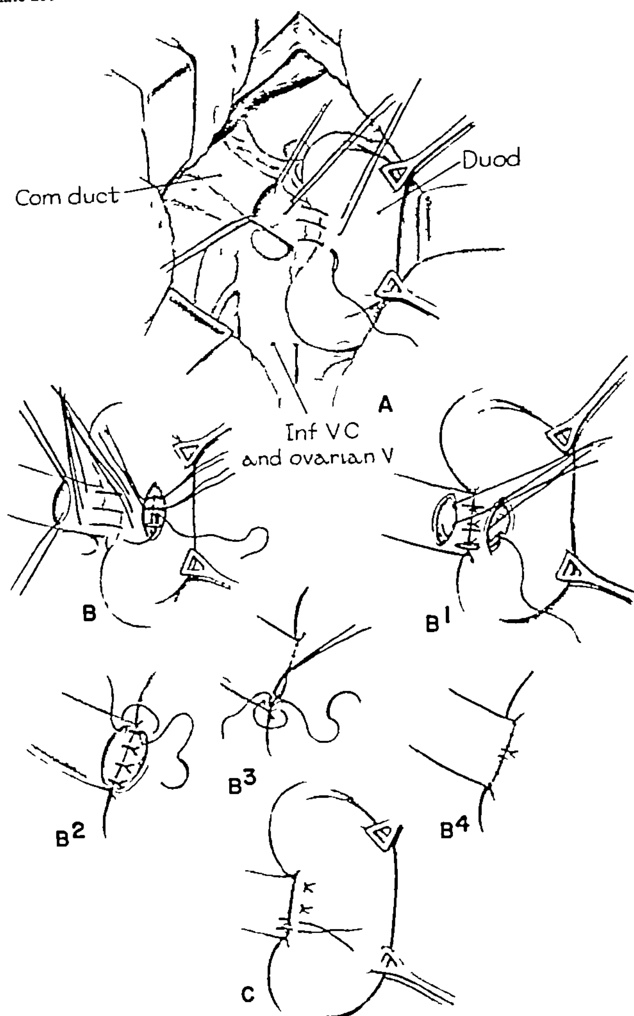
If desired, a choledochoduodenostomy may be performed in preference to a sphincterotomy Although popular among surgeons on the continent of Europe, choledochoduodenostomy has not obtained general acceptance among the surgeons in the United States. However during the past 10 years, the author's experience with its use has been most satisfactory In fact, as a general rule, choledochoduodenostomy is frequently preferred to the performance of a sphincterotomy The continual ingress and egress of duodenal contents into the biliary system is of no clinical importance. Difficulty with this operation should not be anticipated unless stenosis of the anastomotic stoma occurs.

DISCUSSION—DRS. I S RAVDIN AND GERALD W PESKIN While our experience with choledochoduodenostomy is limited because of a preference for sphincterotomy in the treatment of chronic pancreatitis, we have had some success with this procedure. Since the common channel theory of the etiology of pancreatitis provides the rationale for this operation, we believe that complete division of the duct with end-to-side anastomosis of the proximal segment to the duodenum is important. This affords absolute protection against the reflux of bile into the pancreatic ducts, whereas only partial division is accomplished by the technic illustrated in the plates.

After exposure of the area as described under sphincterotomy the common duct is freed from surrounding structures just above the superior edge of the duodenum. A lubricated hernia tape is placed around it, and, with the aid of gentle traction on the tape, the duct is cleared for a distance of 2 cm. A site for transection of the duct which should be as far distally as possible is selected, allowing just enough space to close the distal stump without passing sutures through the pancreas or duodenum. Before transection of the duct, a longitudinal choledochostomy incision is made about one-half inch above the anticipated line of resection for subsequent insertion of a T-tube The duct is then divided with fine, *straight scissors (such as right angle vascular scissors)*, and the distal stump is closed with a running over and over suture of 0000 or 00000 silk (atraumatic) *The duodenal area selected for the anastomosis* shown in Plate 201 A and B, is posterior and distal to the site which we ordinarily use The duodenal incision is usually placed just beyond the junction of the first and second portions at the anterolateral margin This site allows for an anastomosis which is free of kinks. Guide sutures of 00000 silk (atraumatic) are placed at the lateral angles of the common duct opening, and the duct is gently lifted to approximate the duodenum to it The posterior row of interrupted 00000 silk (atraumatic) sutures is placed, taking care not to go completely through all layers of the common duct. In this manner nonabsorbable material is not placed within the duct lumen. When these sutures have been tied, an *opening is* created in the duodenum, approximating the size of the common duct. After hemostasis is obtained, a posterior row of interrupted 00000 chromic catgut (atraumatic) mucosal sutures is placed. A large caliber (No. 16 to No 18) T-tube is then inserted through the longitudinal choledochostomy incision, and its distal limb is led through the anastomotic area and into the duodenal lumen for about 1 inch. The interrupted mucosal suturing is completed anteriorly with the T tube splint affording absolute assurance of a patent lumen. The final step is a serosal closure anteriorly with interrupted 00000 silk (atraumatic). In this manner a splinted, patent, unkinked anastomosis is created The choledochostomy is closed around the T-tube in the fashion described under sphincterotomy and the T-tube is led from the peritoneal cavity through a separate stab wound. Drainage is again by a sump drain placed near the anastomosis and led from the peritoneal cavity through a stab wound.

REFERENCES (see page 640)

Plate 201



CHOLEDOCHODUODENOSTOMY

The technic for exposure of the operative area is the same as that shown in the first plate of the illustrations for sphincterotomy and accordingly is deleted here

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B. The insertion of the first posterior layer of sutures which are not tied is completed. An incision has been made through the seromuscular layer of the duodenum, and the vessels in the submucosa are undersewn with hemostatic sutures of 0000 silk.

B[1] The first posterior layer of sutures is tied, and the second posterior layer of interrupted through and through silk (0000) sutures is being inserted

B[2] B[3] B[4] The insertion of the second posterior layer of sutures is completed, and the first anterior layer is begun. This layer consists of interrupted silk sutures which are inserted from the "inside out" to the "outside in" so that when tied the knots are on the inside of the lumen (B[2] B[3]). These sutures meet in the center of the anastomosis anteriorly where a reinforcing figure of 8 suture ligature is inserted (B).

C. The insertion of the second anterior layer a series of interrupted mattress sutures of *silk (0000) completes the operation.*

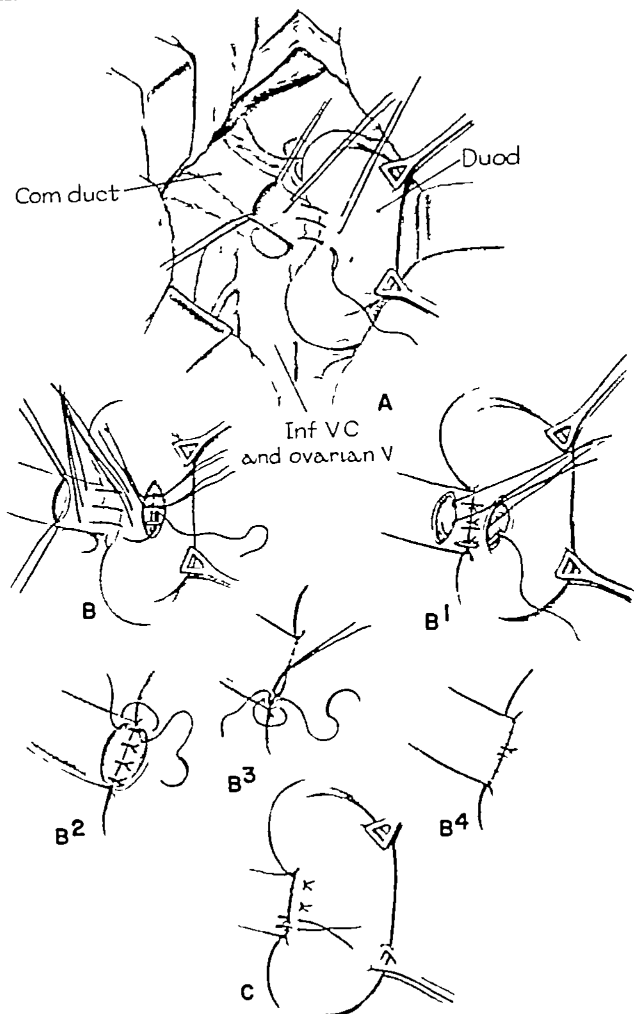
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REFERENCES (see page 640)

Plate 201



RECONSTRUCTION OF THE COMMON BILE DUCT

A. The site of the benign traumatic (postoperative) stricture and the related anatomic structures are visible Exposure of this operative field is obtained as demonstrated in the first plate of illustrations depicting the technic for sphincterotomy

B. The strictured segment is encircled by a guy ligature of silk (0) through which traction is maintained as the duct structures proximally and distally are mobilized by scissor dissection.

B[1] Inset showing the mobilized segment of the common duct distal to the stricture being transected with scissors The level for the transection of the common duct proximally is indicated by the dotted line.

C, D. The transected ends of the common hepatic and common bile ducts are approximated by lateral "angle" sutures of 00000 silk (C) and the insertion of the posterior layer of interrupted through and through sutures of silk (00000) is completed (D).

D[1] The sutures forming the posterior layer are tied and the insertion of the anterior layer of sutures is begun.

E. The completed end to-end anastomosis without an internal splint or stent support is shown. The relation of the distal end of the common duct to the gastroduodenal artery medially and the lymph node laterally is visible

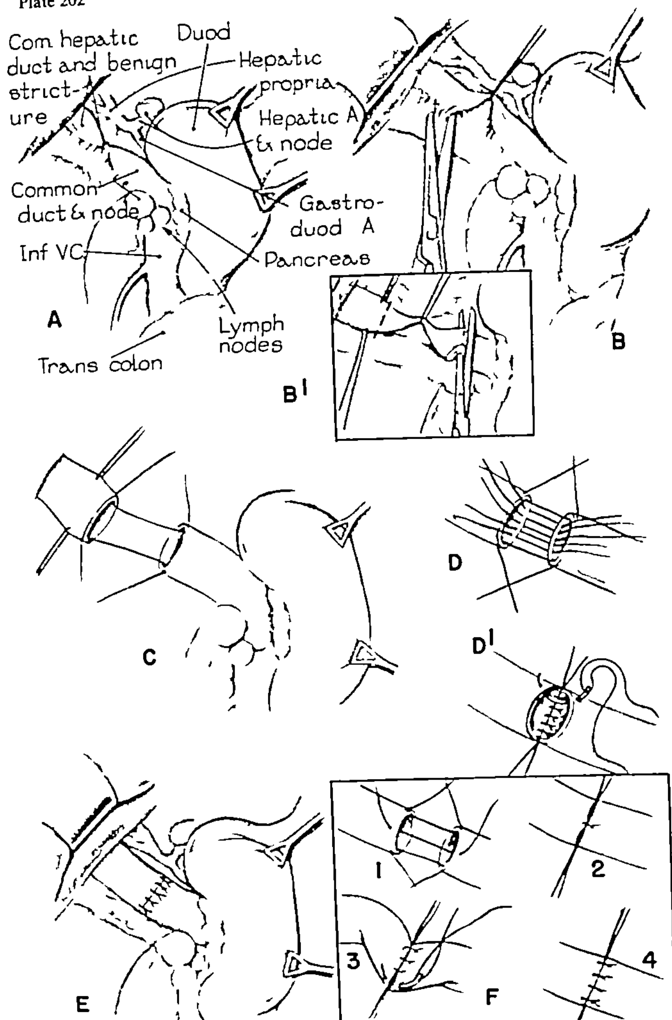
F Inset showing an alternate method of performing an end to-end anastomosis of the common duct. Three cardinal guy sutures of silk (00000) are inserted at equidistant points through the transected ends of the ducts (1) and tied (2) The ends of the guy sutures are left long to facilitate the axial rotation of the duct ends, and the insertion of interrupted silk (00000) sutures completes the anastomosis (3 4) This technic is preferred to the previous one illustrated because the knots of the sutures are on the outside of the lumen, and the foreign body tissue reaction is thereby lessened. Suture knots on the inside of the lumen may be the nidus for the formation of secondary common duct calculi. However in the patient on whom the technic as illustrated (C–E) was used, no untoward clinical manifestations were observed as late as 30 months postoperatively If preferred, interrupted sutures of 00000 chromic catgut on a swedged-on minimum trauma needle may be used.

The technic for reconstruction of the common duct by end-to-end anastomosis without the use of an internal splint or stent is illustrated. Admittedly this is contrary to the generally accepted practice. Most commonly a tube or stent about which the common duct is reconstructed is used and allowed to remain three months, six months, and even a year or longer The necessity for this practice is questioned because a stent, regardless of its type, is a foreign body and, as such, may cause a foreign body tissue reaction. This is believed to be nature's attempt to eject the "intruder" which indeed may become an actuality Furthermore, the tissue reaction may be accompanied by a deposition of varying quantities of fibrous connective tissue. Under such circumstances it is logical to assume that one may be causing that which he is trying to prevent—cicatricial stenosis of the anastomotic stoma. If a stent is used, the necessity for its presence beyond 21 days is dubious

From our own experience, both clinically and experimentally reconstruction of the common bile duct without the use of internal splints or stent supports has proved satisfactory This technic was employed clinically for the first time in October 1950: the patient has remained asymptomatic. Subsequently three other patients were similarly operated upon and have remained asymptomatic for periods of 57 months, 32 months, and 22 months, respectively Experimentally primary and secondary reconstructions of the common duct without the use of stents or internal splint supports have been performed in 84 animals, and, except in one animal, postoperative structures of the common duct did not occur

In the illustrated technic, the anatomic pathologic findings at operation were ideal for the resection of a strictured segment of the common duct and the performance of a primary end-to-end anastomosis. Plastic reconstruction of common duct strictures by a

Plate 202


Com hepatic duct and benign stricture
Duod
Hepatic propria
Hepatic A & node
Common duct & node
Gastro-duod A
Inf VC
Pancreas
A
Lymph nodes
Trans colon
B
B1
C
D
D1
1
2
3
4
E
F

longitudinal incision of the stricture and closure transversely the Heineke–Mikulicz principle is believed basically unsound and is neither practiced nor recommended. Frequently the distal segment of the severed common duct is retracted into the region of the pancreas and, accordingly is not visible. In this regard, the anatomic landmarks stressed by Cattell for the location of this segment of the common duct, namely the lymph node laterally and the gastroduodenal artery medially (E), are a distinct aid. However many surgeons are of the opinion that the distal segment, even if isolated, is too fibrotic for use. This has not been the experience of the author In fact, the apparent normalcy of the tissue is most surprising. Commonly the epithelial lining is glistening in appearance and the lumen is readily distensible, which facilitates the performance of the anastomosis to the dilated duct segment proximally Accordingly an attempt is always made to reconstruct the common duct by an end-to-end anastomosis. If this does not prove feasible an end to-side choledochoduodenostomy without either proximal bile duct drainage or internal splint support is preferred.

DISCUSSION—DRS. I. S RAVDIN AND GERALD W PESKIN Reconstruction of the common bile duct is one of the most difficult of all surgical procedures demanding experience, knowledge of anatomy gentle surgical technic, and patience. This is not a procedure for the occasional operator Wide exposure is necessary preferably through a long subcostal incision Good illumination is of inestimable aid. Dissection is started at the superolateral side of the adhesive mass beneath the liver staying as close to the liver capsule as possible. Once the hepatic flexure of the colon has been freed and rotated to the patient's left, the duodenum is found adherent to the liver hilum. During the dissection necessary to release the duodenum, special attention must be paid to observation for fistulous openings between the bile ducts and the duodenum, and any opening into the duodenum must be carefully closed in layers. All of this dissection is sharp, and the moderate ooze which usually ensues can be readily controlled by firm pressure with a warm, moist sponge The region of the common duct is then approached from the lateral side, using the palpated pulsation of the hepatic artery as a medial landmark. Aspiration with a hypodermic needle is valuable in locating the proximal duct at the liver hilum. If the duct does not protrude below the liver edge, it may be necessary to cut out a segment of liver to free it after bile has been obtained by aspiration The proximal duct is usually large, with a rounded end and a somewhat shiny appearance Once it is cleaned, the Kocher maneuver is performed, and the duodenum is rotated medially to aid in locating the distal segment of duct. It may be necessary to split the pancreatic head or to expose the papilla of Vater through the duodenum in order to find the distal duct. Plate 202, B represents a stage of the operation reached only after considerable time has been consumed in careful, slow dissection. One should not be misled by the clean appearance of the tissues in this plate as this is not the usual situation in our experience. Rather all of the structures of the portal triad are covered with a dense layer of scar

It is important to isolate enough of the duct to perform a good anastomosis, but no more than this should be mobilized lest the vascular supply be damaged to a point of causing poor healing. The use of a hernia tape or silk suture encircling the strictured area is helpful in the mobilization of the duct.

Before cutting away the strictured segment, a longitudinal choledochostomy incision is made about one-half inch proximal or distal to the anticipated line of transection of the duct (usually in the distal duct). The duct is then cut using fine, straight scissors, and angle guide sutures of 00000 silk (atraumatic) are placed. The ends of the segments should be inspected and any frayed areas with doubtful blood supply removed. If there is a question as to the presence of mucosa, a frozen section may be obtained to be certain one is not suturing scar tissue

The anastomosis is begun posteriorly with interrupted sutures of 00000 silk (atraumatic), utilizing the guide sutures for rotating the two ductal segments. The sutures are started from "outside in" rather than from inside out" as shown in Plate 202, D so that the knots are tied on the serosal rather than the mucosal side. In addition, an attempt should be made not to include the full thickness of common duct wall since foreign material within the lumen may serve as a nidus for infection or stone formation. Upon tying the posterior row of sutures, the T tube is inserted through the vertical choledochostomy incision with one limb traversing the anastomosis. The anterior stitches are then placed and tied with the assurance that the T tube has main-

DISCUSSION—DRS. RAVDIN AND PESKIN (cont.)

tained the patency of the lumen. It is often surprising how few sutures are necessary to effect a good anastomosis. It is extremely important that the site at which the T tube leaves the common duct be away from the line of anastomosis, since leading the tube out through the suture line usually is followed by recurrence of the stricture

Closure of the longitudinal choledochostomy incision, drainage, and abdominal wall closure are similar to the technic described under sphincterotomy Before closing, however saline solution should be injected through the long limb of the T tube to test the water tightness of the anastomosis. The T tube is usually left indwelling for from three to six months.

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A. A left rectus paramedian muscle-splitting incision, the one preferred, is depicted. In this patient the spleen was huge and produced a visible bulge on the left side of the anterior abdominal wall.

B. Alternate incisions which may be used a combined abdominothoracic, b' transverse and subcostal incisions the dotted line shows the possible extension of the subcostal incision.

C, D E. The dotted lines indicate the incisions through the anterior rectus sheath, the left rectus muscle and the peritoneum respectively

F The peritoneal cavity is entered, and the wound margins are retracted to show the notched border of the enlarged spleen and its related structures

G By careful manual manipulation the spleen is displaced medially and the incision in the layer of peritoneum which forms the posterior layer of the lienorenal ligament is shown in dotted outline. Ordinarily this layer is avascular However in some instances of hypersplenism, particularly the so-called Banti s syndrome, its marked vascularity necessitates the application of clamps prior to division.

H. By digital manipulation in the retroperitoneal tissue plane, the mobilization of the spleen is continued. The lienocolic ligament is shown doubly clamped before it is severed.

Discussion—Dr William D Holden. The principal hazard encountered in performing a splenectomy is hemorrhage. The operative procedure may be relatively simple, or it may tax the patience and ingenuity of the surgeon to the utmost

The type of incision is of great importance in facilitating technical maneuvers during the operation. The left paramedian incision (Plate 203 A) extending upward to the vicinity of the xiphoid process provides better exposure than either a transverse or subcostal incision (Plate 203 B). This extension is especially worthwhile because the densest peritoneal attachments of the spleen to the posterior parietal peritoneum are frequently at the upper pole. The gastrosplenic ligament can also be exposed and clamped most easily when the incision is extended upward as far as possible. When a splenorenal anastomosis is anticipated and considerable portacaval collateral channels exist, a combined thoracoabdominal incision (Plate 203 B) provides better exposure and minimizes the danger of bleeding. A combined incision is not ordinarily necessary however even when splenic venous hypertension exists, if care is taken and the surgeon has had experience with this type of surgery

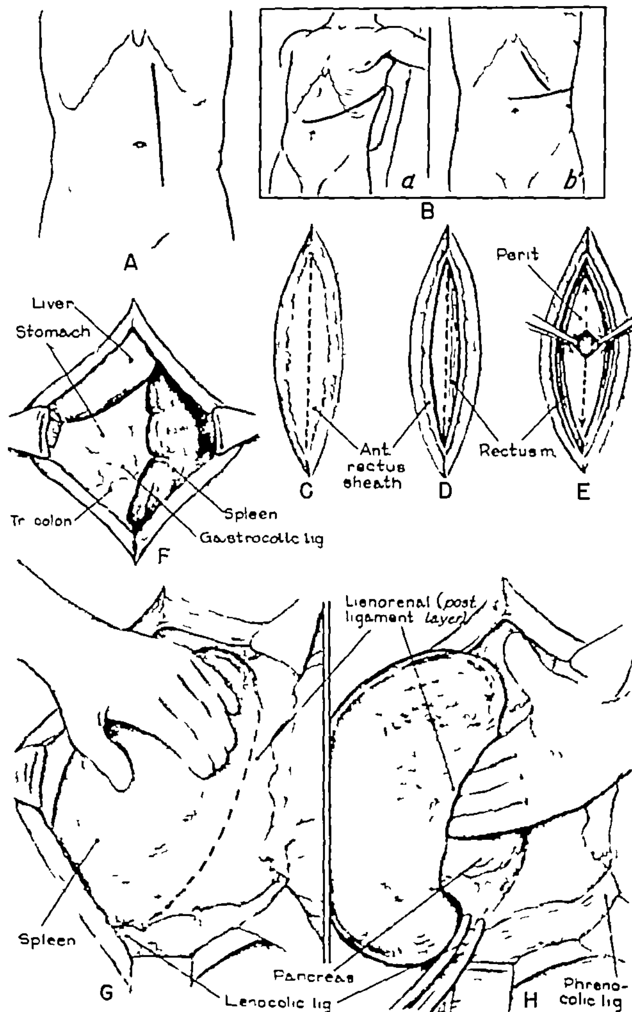
With a paramedian incision the muscle preferably should be retraced laterally rather than split (Plate 203 D). Fewer anatomic relationships are disturbed, and trauma to the motor branches of the intercostal nerves supplying the rectus is reduced.

When a splenectomy is being performed for thrombocytopenia, the subcutaneous tissue in the incision oozes blood diffusely and continuously while the remainder of the incision through the abdominal wall is being made. This is apt to occur to a variable degree whether or not fresh whole blood or platelet suspensions are given just prior to the operation. This oozing ordinarily stops during the course of the operation and should not disconcert the operator

After incising the peritoneum, the surgeon should not explore manually the peritoneal cavity of thrombocytopenic patients because of the likelihood of producing retroperitoneal ecchymoses which can assume significant proportions.

Because of difficult exposure, it is not always possible to incise the lienorenal ligament, which, in essence, is the posterior parietal peritoneum as it comes medially and anteriorly over the spleen (Plate 203 G). With experience the retroperitoneal space may be entered with the tip of a finger and the peritoneum separated bluntly It is important not to place this peritoneal opening too close to the spleen, in order to avoid stripping the peritoneum from the splenic tissue, with resulting bleeding.

The gradual and gentle separation (Plate 203 H) of the splenic pedicle from other retroperitoneal tissues is perhaps the most important maneuver in the operation A few extra minutes here may save considerable blood loss and many minutes of frustrating effort to control the bleeding. After completion of this manipulation, the spleen will ordinarily be sufficiently mobile to enable the remainder of the operation to be done under direct vision. Occasionally however the spleen cannot be completely mobilized because of insufficient length and elasticity of the splenic vessels. In these circumstances, it is worthwhile to place a sponge or hernial tape loosely about the pedicle so that any sudden hemorrhage can be controlled promptly If it becomes necessary to tighten this hemostatic tourniquet, the


A
a
b
B
Perit
Liver
Stomach
Ant
rectus
sheath
Rectus m
C
D
E
Tr colon
Spleen
Gastrocolic lig
F
Lienorenal (post
ligament layer)
Spleen
Pancreas
G
Lenocolic lig
H
Phreno-
colic lig

I. The mobilization posteriorly is completed, and the spleen is easily displaced upward into the abdominal incision. The posterior aspect of the splenic pedicle and its relation to the tail of the pancreas is demonstrated. In the dissection posteriorly particular precaution should be taken to avoid injury to the tail of the pancreas which is frequently in close approximation to the hilum of the spleen and its vascular pedicle.

J. The spleen is withdrawn through the incision and rotated laterally onto the anterior abdominal wall, and traction upward on the greater curvature of the stomach is maintained. The line of division of the anterior layer of the gastrosplenic ligament and its contained vasa brevia is shown in dotted outline.

K. The division of the gastrosplenic ligament is almost completed, and the anterior aspect of the splenic pedicle is visible. The uppermost part of the anterior layer of the gastrosplenic ligament is relatively short. Accordingly in the application of clamps to this ligament one must be careful to avoid injury to the greater curvature of the stomach and the superior pole of the spleen. Furthermore, the uppermost part of the gastrosplenic ligament contains one of the vasa brevia. An avulsion tear of this vessel may be a frequent cause of troublesome hemorrhage during the performance of a splenectomy.

L. The spleen is completely mobilized and its vascular pedicle, which is contained within the posterior layer of the gastrosplenic ligament and the anterior layer of the lienorenal ligament, is triply clamped prior to its division between the two distal clamps. In the application of the clamps to the splenic pedicle, injury to the tail of the pancreas should be avoided. If preferred, triple ligation in continuity without the use of clamps may be performed. The center ligature is of the transfixion type distal to which the pedicle is severed. The artery and vein may be ligated either separately or as a unit structure. This method is used frequently because of the friability of the vessels. In every splenectomy performed for hypersplenism, a diligent search is always made for accessory splenic nodules, one of which is depicted in juxtaposition to the hilum. Removal of all such nodules is mandatory.

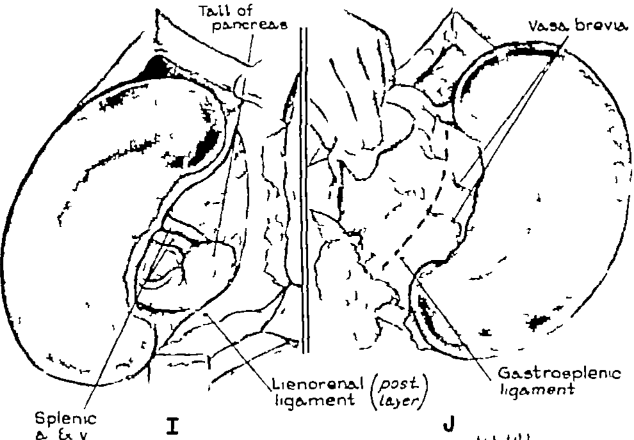
M. N. The application of a proximal ligature and a distal transfixion suture ligature of silk (00) to the vascular pedicle following the removal of the spleen is depicted.

DISCUSSION—DR. HOLDEN (cont.)

tail of the pancreas may be included in it. Temporary constriction of the pancreas, however, does no permanent damage.

The splenic artery and vein may be brittle or friable, especially in elderly patients. In these circumstances, no effort should be made to separate the vein from the artery for individual ligation. Because of the danger of tearing the vessels, the application of clamps (Plate 204, L) prior to ligation is not always desirable. Two 00 silk ligatures passed around the main vessels create less trauma and are less hazardous.

Fortunately, most accessory spleens (Plate 204, L) will be encountered around the hilus of the spleen. Throughout the operation, however, the surgeon must be aware of the possibility of finding them elsewhere, such as along the course of the splenic vessels, in the gastrocolic omentum, or even in the tail of the pancreas.



Accessory spleen

Gastrosplenic ligament

K

L

Colon

Pancreas

Lienorenal ligament

Splenic a.

Splenic v.

M

N

O The operation is completed, and the occluded vascular pedicle of the spleen and its related structures are demonstrated.

P The anatomic relations of the intraperitoneal viscera prior to wound closure.

Q R, S. Layer closure of the abdominal incision using interrupted mattress sutures of 00 silk for the peritoneum, interrupted sutures of 00 silk for the fascia, and interrupted sutures of 000 silk for the skin.

T This insert depicts the preliminary double ligation in continuity of the splenic artery as advocated by the late A. O Singleton as a technical aid in the removal of a large or densely adherent spleen. The lesser sac is entered through an opening in the gastrocolic ligament, and the splenic artery is identified by inspection and palpation as it courses along the superior border of the pancreas. The peritoneum of the posterior wall of the lesser sac overlying the pancreas is divided and the artery is ligated in continuity with two ligatures of silk (00)

DISCUSSION—DR. HOLDEN (cont.)

Preliminary double ligation in continuity of the splenic vessels (Plate 205 T) to facilitate the removal of a densely adherent spleen can be of value. When a previous inflammatory process has been present along the upper border of the pancreas, it is not always easy to dissect the vessels out. Ligation must be done distal to the origin of the left gastroepiploic artery otherwise, little is gained.

An essential feature of this operation is careful inspection for bleeding of the splenic pedicle and the denuded retroperitoneal space after the spleen has been removed. It is much easier to find a small bleeding vessel, and to either ligate or suture it, at this time than several hours later

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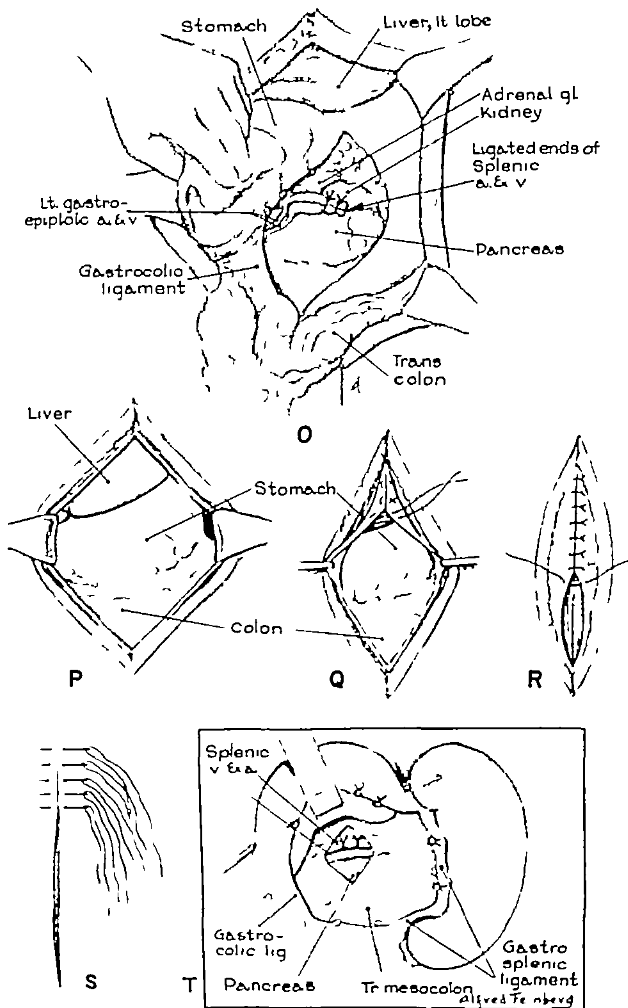
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Stomach
Liver, lt lobe
Adrenal gl
Kidney
Ligated ends of Splenic a. & v
Lt. gastro-epiploic a. & v
Pancreas
Gastrocolic ligament
Trans colon
O
Liver
Stomach
Colon
P
Q
R
Splenic v & a
Gastro-colic lig
Pancreas
Tr mesocolon
Gastro splenic ligament
S
T
Alfred Feinberg

A. The right paramedian upper abdominal incision is shown by the solid line

B. The peritoneal cavity is entered, and the right side of the transverse colon is displaced downward to show the middle of the second portion of the duodenum, the perivaterian segment, encircled by a constriction ring of pancreatic tissue.

C, D The annular constriction ring of pancreas is mobilized by blunt dissection on a curved (Kelly) clamp (C) preparatory to being doubly clamped and severed (D)

E. The severed ends of the constriction ring are occluded with suture ligatures of silk (00) One of the suture ligatures is inserted and the other is being inserted prior to removal of the clamp Even though the annular island of pancreas was severed, the constriction effect on the lumen of the duodenum was noted to persist. Furthermore, the circulation of the bowel wall appeared impoverished and was a potential site for spontaneous perforation to occur

F Because of the persistence of the constriction effect on the lumen of the duodenum and the potential danger of spontaneous perforation, a duodenoduodenostomy was deemed advisable Accordingly the area was covered by the insertion of an overlying layer of interrupted seromuscular sutures (000 silk) which also formed the first posterior layer of the duodenoduodenostomy

G. The insertion of the first posterior layer of sutures is completed. An incision is being made through the seromuscular layer of the distal segment of the duodenum to expose the vessels in the underlying submucosa. A *similar incision was previously made in the* proximal segment of the duodenum, and the vessels in the submucosa were undersewn with hemostatic suture ligatures of 0000 silk.

H. Traction is applied to the hemostatic suture ligatures in the distal segment of the duodenum, and the initial scalpel opening into the lumen of the duodenum is extended by scissor dissection. In like manner the lumen of the duodenum proximally was entered prior to cutting the long strands of the hemostatic ligatures.

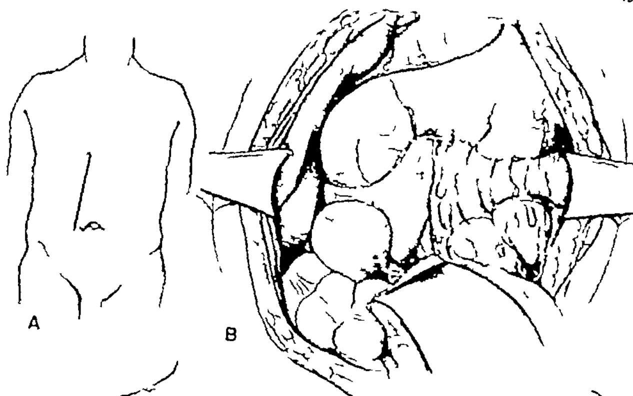
The operation illustrated was performed in a 46-year-old white man who had intermittent digestive symptoms of 10 years duration. These symptoms were characterized by recurrent attacks of abdominal pain, nausea, and vomiting. Roentgenograms demonstrated a partial blockage in the second portion of the duodenum, the cause of which was not determined preoperatively Diabetes mellitus controlled by dietary management was also present.

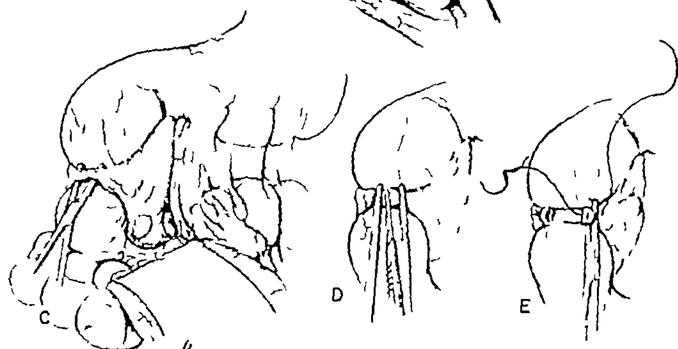
In this patient the annular constriction ring was doubly clamped, severed, and ligated as illustrated. A logical objection to this method is the potential danger of a complicating postoperative pancreatitis secondary to leakage from the severed duct which is usually contained within the constriction ring of pancreatic tissue Although this complication did not occur in the patient operated upon, the severance of the ring did not affect a release of the constriction of the lumen of the duodenum. In fact, the segment of the duodenum uncovered after severance of the annular pancreas was exceedingly thin walled and perforation appeared imminent. Accordingly the area was covered by the insertion of an overlying layer of seromuscular sutures (F G) preparatory to doing a duodenoduodenostomy

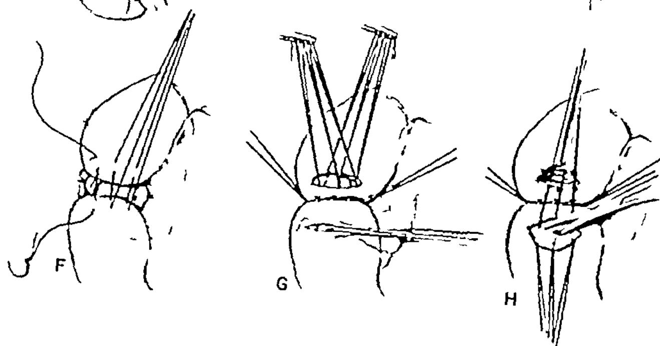
In the surgical treatment of annular pancreas, however severance or resection of the constriction ring of pancreatic tissue about the duodenum should not be done. Either a duodenoduodenostomy (preferred) or a duodenojejunostomy (antecolic or retrocolic) is recommended. The performance of a gastrojejunostomy is not a satisfactory operation because it does not prevent the cyclic attacks of vomiting due to regurgitation of the obstructed duodenal contents into the stomach.

DISCUSSION—DR. THOMAS V SANTULLI In this rare condition, the severity of the symptoms depends on the degree of duodenal obstruction resulting from the constricting ring of pancreas. The obstruction is almost always incomplete, but it may be severe enough to present symptoms in early life. Many of the patients do not come to surgery until late in life because of a relatively mild degree of duodenal obstruction.

The legends accompanying the illustrations state that the division of the constricting pancreatic tissue *may be dangerous. It would be more prudent* not to disturb the pancreas but simply to perform the anastomosis illustrated in F through N Duode


A
B


C
D
E


F
G
H

I, J K. The insertion of the second layer of sutures (000 silk) posteriorly is begun (I) These sutures are first all inserted, tied individually (J), and then cut (K) If preferred, fine chromic catgut (000–0000) sutures may be used for the approximation of the mucosal layers. However no complications have been observed with the use of silk sutures as depicted. The insertion of the first layer of sutures anteriorly is begun at either "angle" of the anastomosis (K). Each suture is inserted from the "inside out" to the "outside in" so that, when tied, the knots are on the inside of the lumen and inversion of the tissue layers is obtained.

L. The last two sutures of the first anterior layer of the anastomosis are encircled by an untied figure of 8 mattress suture

M N The long strands of the terminal two sutures are cut, and the figure of 8 mattress suture is tied to reinforce the site of termination of the first anterior layer of the anastomosis The *interrupted seromuscular* (Lembert) sutures (000 silk) which form the second anterior layer are all first inserted (M), tied individually and then cut (N), to complete the duodenoduodenostomy

O P An operation performed by many in the treatment of annular pancreas (O) is the use of a simple bypass, side to-side anastomosis between the proximal portion of the duodenum and the jejunum. The anastomosis may be performed either anterior (antecolic) as depicted or posterior (retrocolic) to the colon.

DISCUSSION—DR. SANTULLI (cont.)

noduodenostomy seems preferable to the duodenojejunostomy illustrated in P

However in infancy the anastomosis of choice is duodenojejunostomy because of the anatomic findings and technical considerations. In all instances, it is preferable to avoid gastrojejunostomy

In infancy one of the important considerations is the high incidence of serious associated anomalies, i.e., malrotation, Mongolism, duodenal atresia, and so forth. The prognosis usually depends on these associated anomalies.

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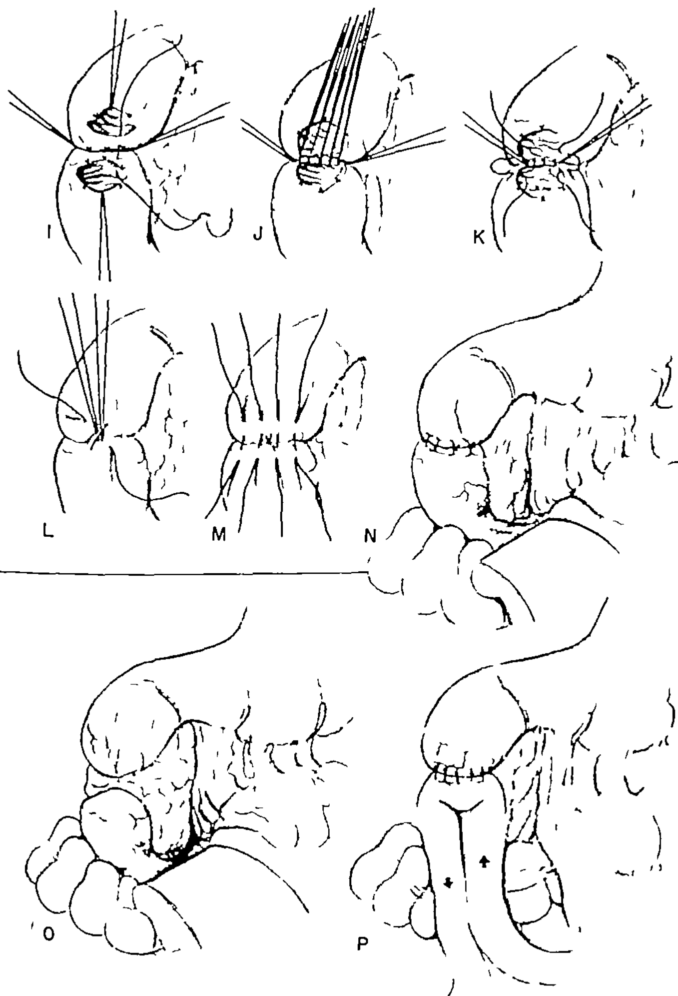
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I
J
K
L
M
N
O
P

PSEUDOCYSTS OF THE PANCREAS

In this patient two pseudocysts of the pancreas, one in the head and one in the tail, were present. In addition multiple calculi both in the gallbladder and in the common duct were found. Accordingly drainage of the cysts, cholecystectomy and choledochostomy were performed.

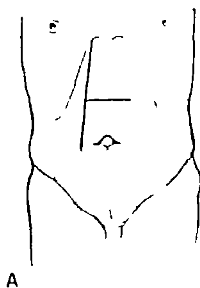
A. The right paramedian muscle-retracting (lateral) incision and the extension from its midpoint transversely to the left are shown by the solid lines.

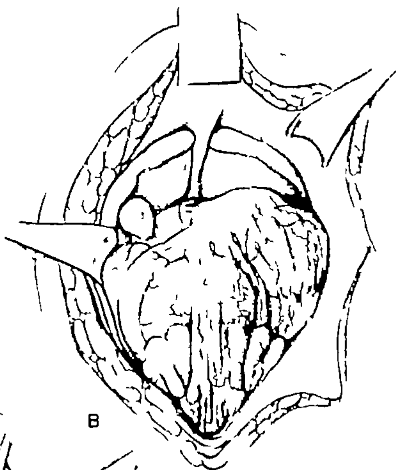
B. The peritoneal cavity is widely exposed, and the relation of the pseudocysts of the pancreas to the surrounding structures is visible

C. The right hepatic flexure of the colon is mobilized and displaced downward toward the left lower quadrant, and the mobilization of the duodenum by scissor dissection of the posterior parietal peritoneum is indicated by the dotted line. The widened duodenal sweep is clearly shown.

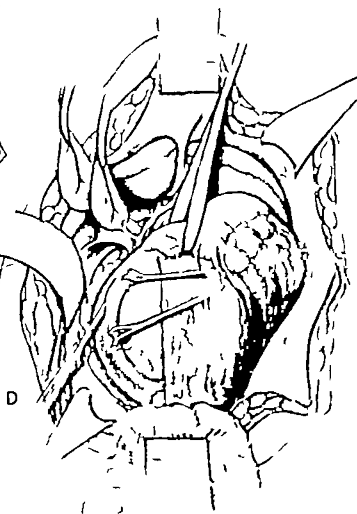
D The mobilized duodenum is secured by Babcock clamps while an incision is being made through its seromuscular layer

Plate 208





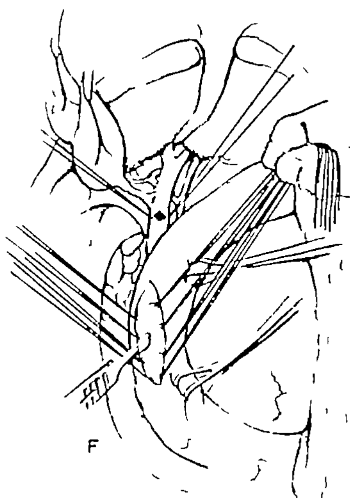


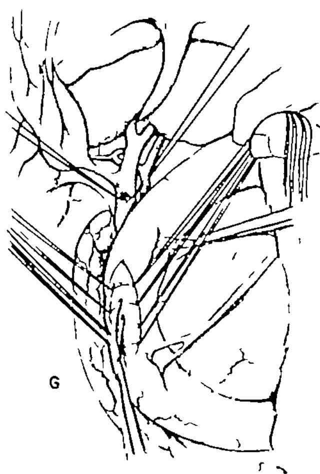


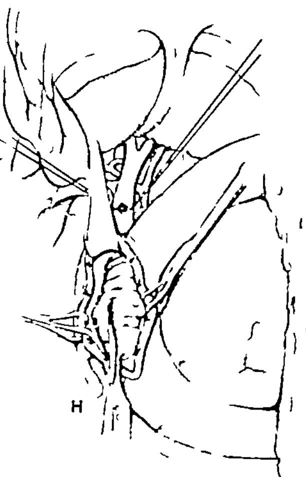
E, F The common duct is opened, and a Bakes dilator is inserted distally toward the papilla of Vater Multiple stones were removed from the common duct, subsequent to which the dilator readily entered the lumen of the duodenum (E) The vessels in the submucosal layer of the duodenum are undersewn with hemostatic suture ligatures of 0000 silk (E) preparatory to incision into its lumen with a scalpel (F).

G H. The opening into the lumen of the duodenum is enlarged by scissor dissection (G) and the cut margins are retracted to show the incision being made through the mucosal layer of the posterior wall of the duodenum (H).


E

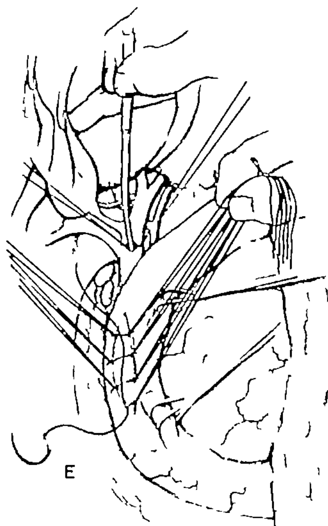

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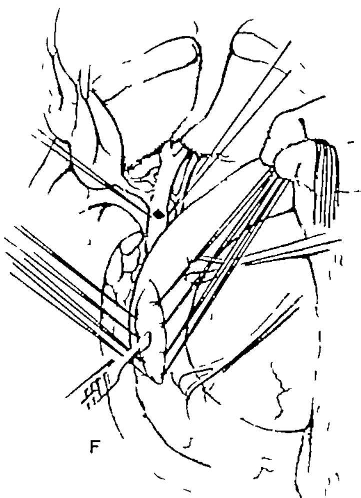

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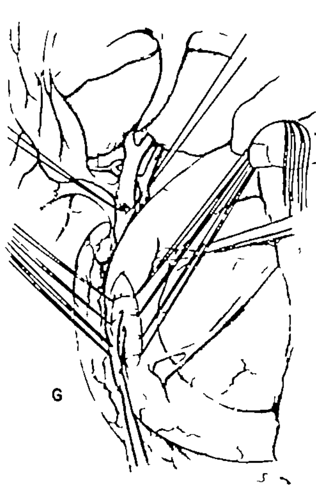

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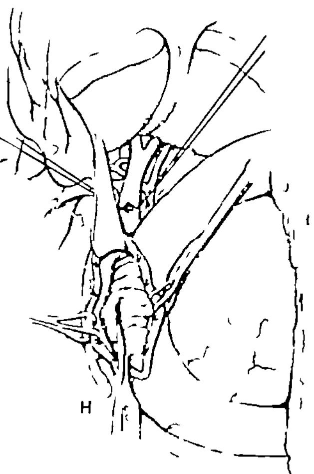
E, F The common duct is opened, and a Bakes dilator is inserted distally toward the papilla of Vater Multiple stones were removed from the common duct, subsequent to which the dilator readily entered the lumen of the duodenum (E) The vessels in the submucosal layer of the duodenum are undersewn with hemostatic suture ligatures of 0000 silk (E) preparatory to incision into its lumen with a scalpel (F).

G H. The opening into the lumen of the duodenum is enlarged by scissor dissection (G), and the cut margins are retracted to show the incision being made through the mucosal layer of the posterior wall of the duodenum (H).


E

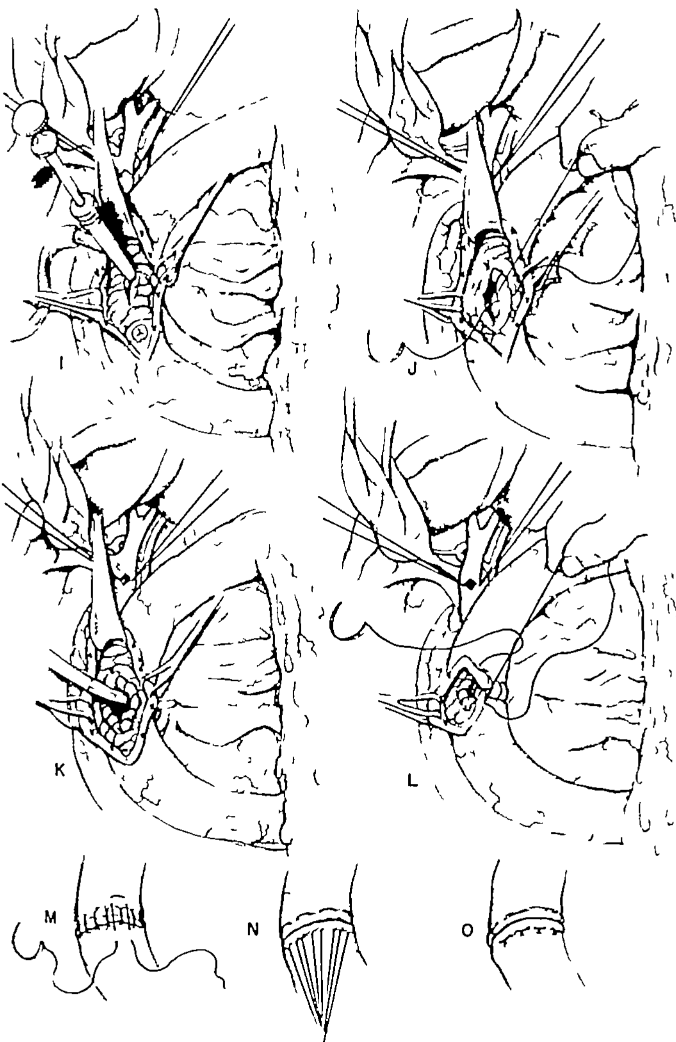

F


G


H

E, F The common duct is opened, and a Bakes dilator is inserted distally toward the papilla of Vater Multiple stones were removed from the common duct, subsequent to which the dilator readily entered the lumen of the duodenum (E) The vessels in the submucosal layer of the duodenum are undersewn with hemostatic suture ligatures of 0000 silk (E) preparatory to incision into its lumen with a scalpel (F).

G, H. The opening into the lumen of the duodenum is enlarged by scissor dissection (G), and the cut margins are retracted to show the incision being made through the mucosal layer of the posterior wall of the duodenum (H).

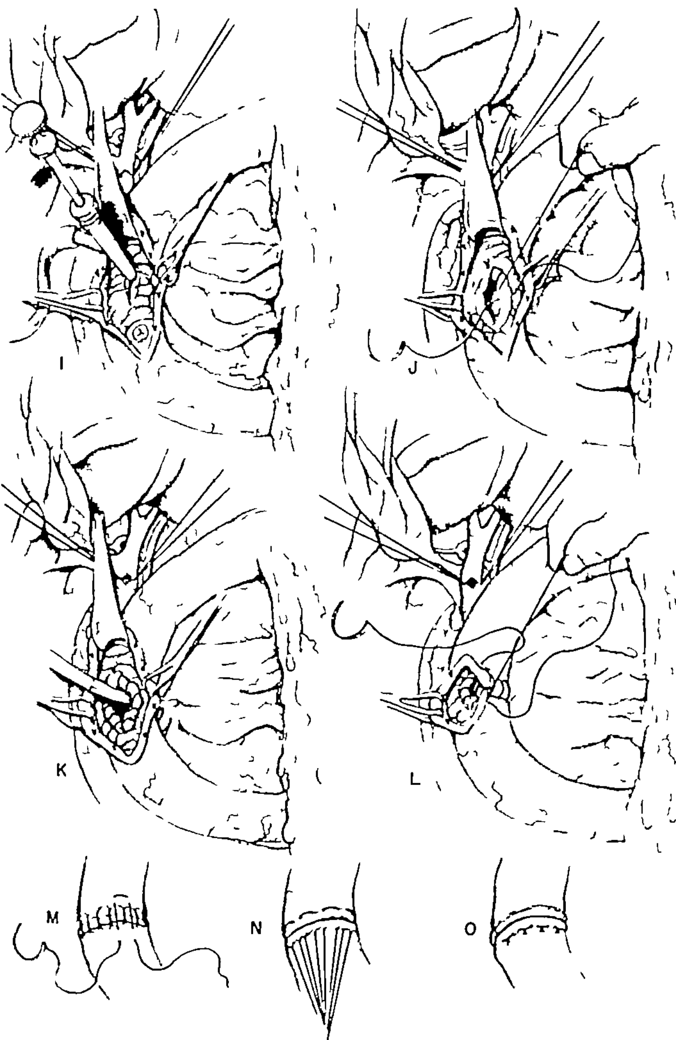

I
J
K
L
M
N
O

I. A trocar and canula are inserted into the cyst cavity through the partially incised posterior wall of the duodenum, and, on withdrawal of the trocar suction decompression of the cyst within the head of the pancreas is performed.

J The opening into the cyst cavity is enlarged by scissor dissection, and the incised margins are oversewn with a continuous hemostatic suture of chromic catgut (00).

K. The anterior wall of the cyst may be seen elevated on the tip of a clamp inserted through the opening in the posterior wall of the duodenum.

L, M, N O The longitudinal opening in the anterior wall of the duodenum is closed in a transverse plane by a continuous interlocking suture of 000 silk (L) A second layer of inverting Halsted mattress sutures are inserted (M, N) and tied (O) to complete the closure of the duodenotomy incision.


I
J
K
L
M
N
O

P The pancreatocystoduodenostomy is completed, and the incision for the transgastric drainage of the cyst in the tail of the pancreas is shown by the solid line Prior to making this incision, the lesser sac was entered and the spleen was mobilized in anticipation of performing a combined splenectomy and excision of the cyst bearing area of the tail of the pancreas However the extent of the inflammatory induration of the tissues precluded the completion of the contemplated operation

Q The longitudinal incision through the seromuscular layer of the anterior wall of the stomach is completed, and the vessels in the submucosal layer are undersewn with suture ligatures of silk (000)

R, S. A scalpel is used to make an opening into the gastric lumen (R) which is enlarged by scissor dissection (S)

T The incised margins of the anterior wall of the stomach, grasped in Babcock clamps, are retracted to show the incision being made through the mucosa of the posterior gastric wall

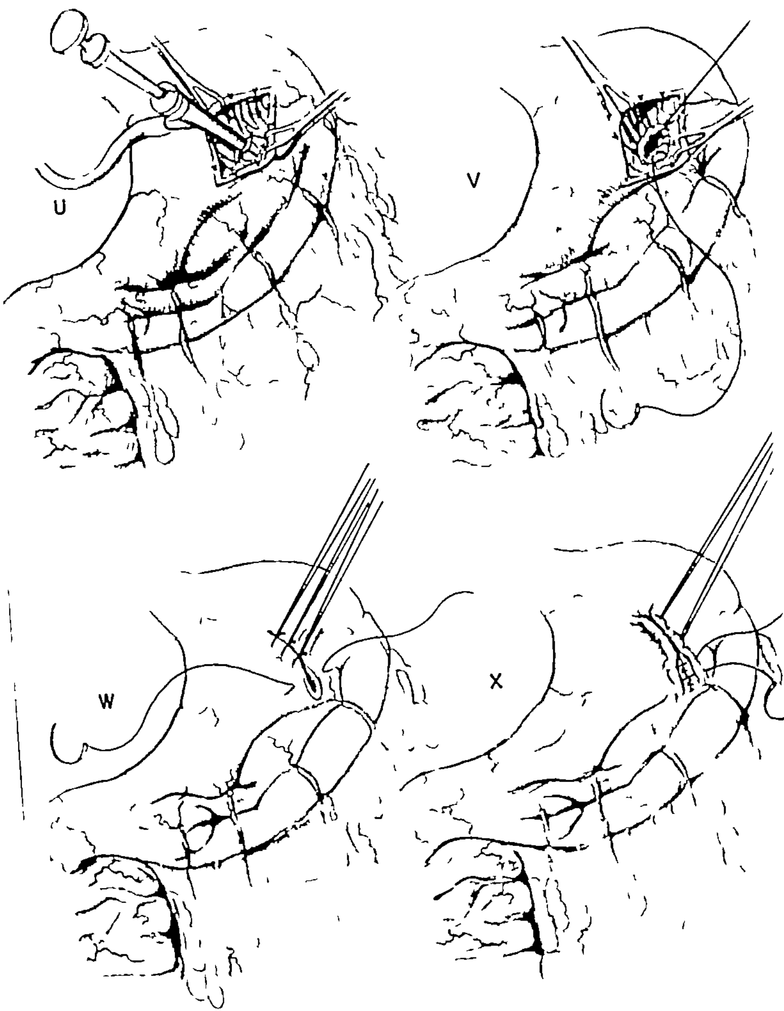

P
Q
R
S
T

U A trocar and canula are inserted through the incised mucosa into the lumen of the cyst which is drained by suction siphonage.

V Following the decompression of the cyst, the opening into its cavity is enlarged (3 to 4 cm.) by scissor dissection, and the incised margins are oversewn with a continuous hemostatic ligature of 00 chromic catgut.

W X. The longitudinal incision in the anterior wall of the stomach is closed transversely to its longitudinal axis with interrupted through and through sutures of silk (W). This line of closure is then reinforced with a series of interrupted seromuscular inversion mattress sutures (000 silk) of the Halsted type (X)

Plate 212



Y Upon completion of the transgastric pancreatocystogastrostomy the stones present in the common duct are removed preparatory to excision of the gallbladder Prior to the exploration of the common duct the cystic duct is ligated (00 silk) to prevent the possibility of egress of stones from the gall bladder *into the common duct.* Subsequently the cystic duct is doubly clamped proximal to the ligature previously applied and is severed between the clamps.

Y[1] A transfixion suture ligature of silk (000) is inserted between the clamp and the ligature on the distal severed segment of the cystic duct to reinforce its closure

Y[2] The proximal severed end of the cystic artery which arises from the convex arch formed by the right hepatic artery is similarly ligated, and the gallbladder is being mobilized from its liver bed by incision of its peritoneal attachments.

Y[3] The cholecystectomy is completed, and the incision in the common bile duct is being closed with 00000 arterial silk sutures about a catheter (12 F) which is preferred *to a T tube* for drainage of the common duct.

Z. This illustration shows the whole of the operative field upon the completion of the transduodenal and transgastric drainage of the pancreatic cysts, the cholecystectomy and the common duct exploration. A Penrose cigarette drain, which is routinely used, is inserted into the foramen of Winslow prior to closure of the abdominal incision. The catheter and the drain have separate exits through the abdominal incision rather than through stab wounds in the flank.

Although in the past trauma has been considered a frequent etiologic factor in the formation of pseudocysts of the pancreas, it is believed that the basic cause is an acute pancreatitis either with or without associated biliary tract disease.

Pseudocysts differ from true cysts of the pancreas in that they have no epithelial lining However the same may obtain in true cysts of long standing because *of pressure atrophy of the lining membrane*

In the surgical management of pseudocysts, excision is frequently mentioned as the ideal in treatment. However based on the most probable pathogenesis of the formation of pseudocysts, namely acute pancreatitis with the escape of pancreatic fluid usually into the lesser sac wherein it is encysted, this is not believed a feasible operation. The operation most commonly used is marsupialization. This is technically simple and was performed for the first time in 1881 by Gussenbauer The objections to this operation are (1) persistent fistula, (2) skin excoriation, and (3) recurrent cyst formation.

In the treatment of cysts located in the tail of the pancreas, resection of this segment of the gland with splenectomy may be performed in selected instances Rarely proximal pancreatoduodenectomy may be required as a curative procedure in instances of severe pancreatic fibrosis of the head of the pancreas complicated by pseudocyst formation.

In recent years internal drainage of pseudocysts into the proximal gastrointestinal tract has become increasingly popular Cystogastrostomy was employed first by Jedlicka in 1923 In 1929 Jurasz performed a transgastric cystogastrostomy and, in the same year Kerschner drained a cyst of the head of the pancreas by the transduodenal route. The technic for each of these procedures is depicted in detail in the illustrations. They are the preferred methods for internal drainage of pseudocysts either in the head or tail of the pancreas. The theoretic objection that the stomach or duodenal contents may pass into the cyst rather than the reverse is not substantiated in fact.

Hahn, in 1926, first employed the jejunum for the *drainage of pseudocysts. Chesterman of England re*ported its use in 1943 and was under the mistaken impression that this was the first time that pancreatocystojejunostomy was performed. Technics for its performance are illustrated in Plate 214 At present the use of the jejunum, particularly the Roux en-Y type of anastomosis (Plate 214 A and A), is believed the method most generally employed. However the simplicity and the therapeutic effectiveness of transgastric and transduodenal drainage, either alone or combined as in the case illustrated, are factors which are believed to make either of these methods preferable to others for internal drainage of pseudocysts of the pancreas.

Finally sphincterotomy stressed particularly by Doubilet, may be employed. Although not used by the author in the treatment of pseudocysts of the pancreas, it is considered sound in principle, and it may prove an effective and preferred method of treatment. However if it is used, there must be demonstrated a free communication between the cyst contents and the pancreatic duct to allow free drainage into the duodenum following the sphincterotomy The presence of an obstruction between the duodenum and the pseudocyst precludes its use unless the obstructive factor is concomitantly relieved.

Plate 213



A. The internal dependent drainage of a pseudocyst of the head of the pancreas by a Roux-en Y type of anastomosis using an isolated limb of jejunum is demonstrated. The jejunum is transected 15 to 20 cm. from the ligament of Treitz, and the length of the isolated segment of jejunum cephalad to the end to-side jejunojejunostomy varies between 30 and 35 cm

A[1] If preferred, a side-to-end rather than a side-to-side cystojejunostomy may be used.

B B[1] A pancreatocystojejunostomy may also be employed as a simple side to-side anastomosis either without (B) or with (B[1]) a concomitant proximal enteroenterostomy (Braun anastomosis)

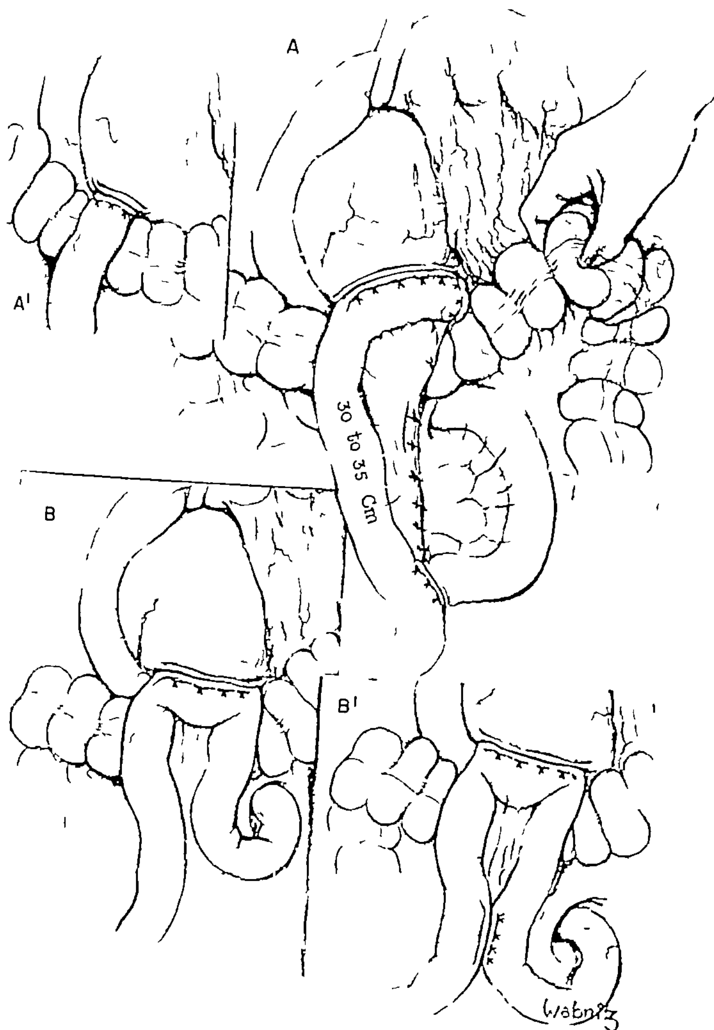
Discussion—Dr. Henry Doubilet Since pseudocyst formation is one of the complications of an attack of acute pancreatitis, it is important to consider the etiology of the acute attack In my opinion, the disease is caused by reflux of bile into the pancreatic duct as a result of spasm of the sphincter of Oddi. If the necrotizing process opens one or more of the smaller ducts, pancreatic juice passes into the retroperitoneal space in which the pancreas lies. Since resistance to flow into this space is less than through the spastic sphincter the pseudocyst enlarges and extends It will not become stabilized until the resistance of surrounding structures is equal to the resistance of the sphincter of Oddi. It is not necessary to excise, drain, or anastomose pseudocysts. Section of the sphincter of Oddi reduces the pancreatic intraductal pressure, and the pseudocyst will empty through the pancreatic duct into the duodenum At the same time, sphincterotomy will cure the underlying disease of pancreatitis and prevent further formation of pseudocysts, a not unusual event following procedures such as marsupialization or anastomosis.

The case presented here might serve to illustrate this principle After cholecystectomy and removal of the common duct stones, the sphincter might have been sectioned. Following this, a plastic tube could have been inserted into the duct of Wirsung and a pancreatogram performed. In the absence of any obstruction in the pancreatic duct, no further procedure would have been necessary The two pseudocysts would have collapsed and disappeared This has been our experience in 26 cases

If pancreatographic study reveals obstruction in the duct, I prefer to perform a split pancreaticojejunostomy The body of the pancreas is transected, and the ends of the sectioned duct are anastomosed to each side of a loop of jejunum (Roux-en-Y). This procedure permits drainage of the pancreatic duct from the tail, the body and the head, and at the same time conserves all the pancreatic tissue. As a result of reduction of intraductal pressure, the pseudocyst disappears. The operations depicted by the author are unnecessary They are anatomically unsound, since essentially each of these procedures produces an anastomosis between the gastrointestinal tract and the retroperitoneal space.

Several other points may be worth noting. The lesser omental sac is not part of the retroperitoneal space, and pseudocysts do not form there but behind it. Inflammatory adhesion of the posterior parietal peritoneum to the posterior wall of the stomach merely gives this impression. The posterior parietal peritoneum overlying the pancreas is firmly adherent and, in our experience, is not seen lifted off the surface of the organ as illustrated in Plate 215 The exudate often spreads behind the pancreas and pushes it anteriorly The incision depicted in Plate 208, A, gives an adequate approach to the biliary tract and pancreas, but, in the experience of this commentator a transverse incision is superior in terms of exposure, ease of closure, and resulting firmness of the wound.

A final point that might be stressed is that, on physiologic grounds, it is preferable to close the duodenal incision (Plate 208, D) in a longitudinal direction instead of transversely (Plate 210, L, M, N O) I believe that this produces less interference with the very important peristaltic activity of the duodenum. Closure is made in two layers, a running everting chromic suture (000) to the mucosa for hemostasis, and interrupted fine silk sutures to draw the muscle and serosa together


A
A[1]
30 to 35 Cm
B
B[1]
Wabnitz

This plate (after Judd, Mattson, and Mahorner) depicts the common pathways of extension of pseudocysts of the pancreas. In addition to those illustrated, extension of a pseudocyst into the posterior mediastinum may also occur

A. Projection of the cyst between the inferior surface of the liver and the anterior wall of the stomach is shown. This is the second most common pathway of enlargement. Access to cysts in this area is best obtained through an opening in the gastrohepatic ligament.

B. This is the most common location for pseudocysts of the pancreas namely between the stomach above and the transverse colon below Access to cysts in this area is readily obtained through the gastrocolic ligament.

C, D Pseudocysts of the pancreas may project between the leaves of the transverse mesocolon and enlarge downward toward the pelvis (C) or ventrally toward the anterior abdominal wall (D)

E. In some instances pseudocysts may extend retroperitoneally either upward into the posterior mediastinum or downward into the pelvis as depicted. When a retroperitoneal extension into the pelvis occurs, there may be difficulty in differentiating it from a large ovarian cyst. In fact, in the case reported by Bozeman (1882) which was the first successful excision of a pseudocyst of the pancreas reported, the preoperative diagnosis was an ovarian cyst.

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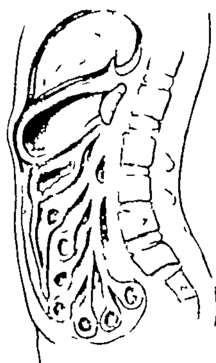
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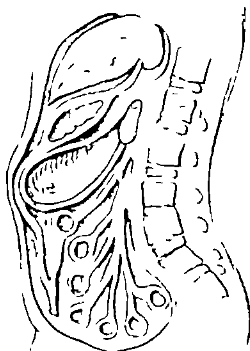
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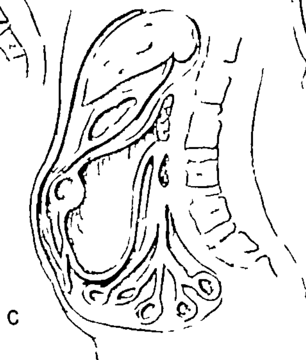
Plate 215



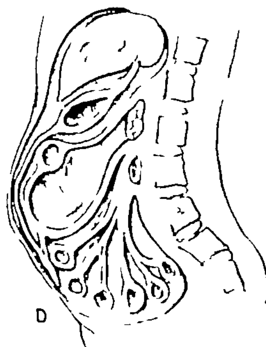
A



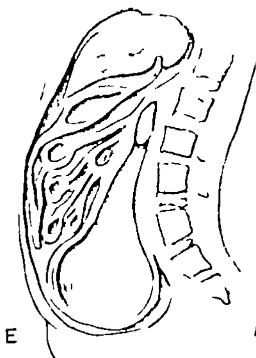
B



C



D



E

TRANSDUODENAL EXCISION OF TUMOR ABOUT THE PAPILLA OF VATER

A. The right upper quadrant oblique para median muscle retracting (lateral) incision employed is shown by the solid black line

B. The peritoneal cavity is entered. After a thorough exploration of its contents in this patient, it was deemed advisable to explore the common duct. On exploration of the duct, a probe could not be passed into the lumen of the duodenum Accordingly pre liminary to mobilization of the retrocolic portion of the duodenum, the right phrenocolic ligament was incised (dotted line)

C. The hepatic flexure is displaced downward and to the left, and the posterior parietal peritoneum is incised by scissor dissection preparatory to mobilization of the duode num (Kocher)

D E. By blunt digital dissection in the retroperitoneal tissue plane the duodenum and the head of the pancreas are mobilized and rotated toward the midline (Moynihan rotation maneuver) (D). Palpation of the du odenum at this time revealed a tumor mass in the region of the papilla of Vater and, accordingly a duodenotomy was performed (E)

The patient, a seventy year-old white woman, was admitted to the hospital with the history that, during the preceding four months, recurrent attacks of chills and fever of increasing severity were noted. Anemia and a weight loss of 13 pounds were associated clinical mani festations. Jaundice was never a symptom.

During the three week hospital period prior to operation, a battery of diagnostic blood tests, stool examinations, and roentgenographic studies of the stomach, small bowel, colon, and kidneys were done. These were all normal. The only positive roentgenographic finding was a faint visualization of the gallbladder following ingestion of the dye. In view of this finding and in conjunction with the remittent fever and the persistence and progressive severity of the recurrent bouts of chills and fever operation was advised. The operative findings and the surgical procedure performed are illustrated. The postoperative course of the patient was entirely satisfactory A cholangiogram obtained on the seventh postopera tive day was normal. Both catheters were removed two days later and the Penrose drain was removed on the tenth day after operation. The temperature returned to normal within 48 hours after operation and remained normal throughout the remainder of the hospital stay Follow up examination at the end of 10 weeks showed the patient to be in excellent condition, and there were no subjective complaints The pathologic diagnosis was benign sessile papillomatosis with early atypical changes and secondary inflammatory reaction.

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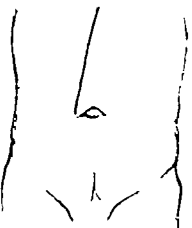
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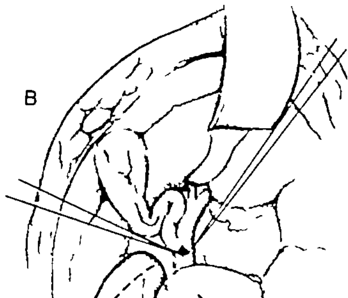
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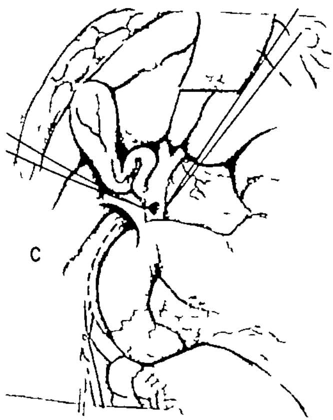
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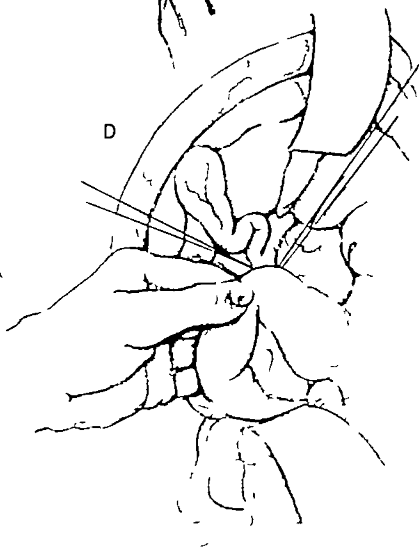
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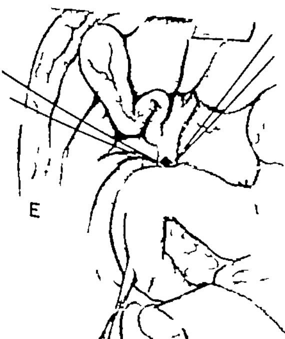
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A


B


C


D


E

F On retraction of the incised margins of the duodenum a sessile, cauliflowerlike mass in the region of the papilla of Vater was observed. Beneath this mass a second firm, oval tumor was palpated. The head of the pancreas and the liver were normal A Bâkes dilator (4 mm.) was inserted into the common duct and protruded through the center of the sessile tumor mass into the lumen of the duodenum.

G The Bâkes dilator was replaced by a catheter (14 F), and a second catheter (14 F) was readily inserted into the adjacent orifice of the pancreatic duct. In view of the local characteristics of the lesion and the age and general condition of the patient, a total excisional biopsy was the operation of choice It was surprising how readily both the common and pancreatic duct orifices were catheterized through the center of the tumor mass.

H I. A transverse elliptical incision is made first through the mucosa of the posterior wall of the duodenum beyond the border of the tumor (H) and then deepened through its underlying layers to expose the terminal portions of the common and pancreatic ducts (I). The oval tumor mass previously palpated beneath the sessile tumor was subsequently proved to be an impacted stone in the intramural portion of the common duct.

J Traction guy sutures of silk (00000) are placed in the walls of the pancreatic and common ducts proximally prior to their severance distally as indicated

K. The transection of the duct structures is completed and the repositioning of the proximal transected ends into the lumen of the duodenum is begun. The cut margins of the elliptical opening in the duodenum posteriorly are approximated with interrupted mattress sutures of silk (000), which include all of the layers of the bowel wall and separate the duct structures from each other

L, M. The mattress sutures are tied, and the transected ends of the pancreatic (L) and common (M) ducts are sutured to the cut margins of the mucosa of the posterior wall of the duodenum using 00000 arterial silk.

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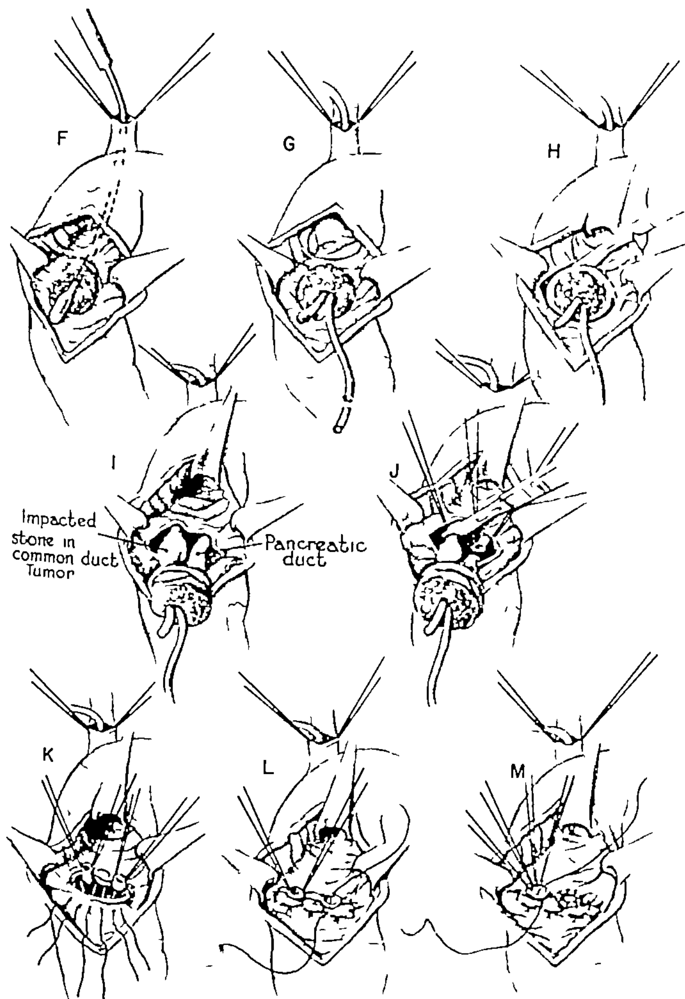
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F
G
H
I
J
Impacted
stone in
common duct
Tumor
Pancreatic
duct
K
L
M

N A catheter (14 F) is inserted in the common duct through its terminal reconstructed orifice into the duodenum. A second catheter (14 F) is inserted transduodenally through the new orifice of the pancreatic duct into its lumen.

O The longitudinal incision in the duodenum is closed transversely using interrupted sutures of silk (000) These sutures commencing at either end are inserted alternately from the "inside out" to the "outside in" so that, when tied, the knots are on the inside of the lumen and the serosal layers are inverted.

P Q A second reinforcing layer of seroserosal mattress sutures of silk (000) are inserted (P) and tied (Q) about the protruding pancreatic duct catheter

R S. By traction on the terminal mattress sutures anteriorly the bowel wall is rotated on its longitudinal axis, and a layer of seroserosal mattress sutures of silk (000) is inserted (R) and tied (S) to reinforce the line of closure posteriorly

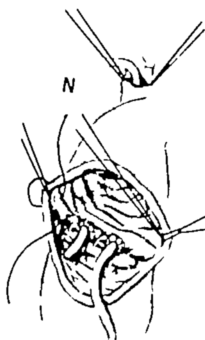
T The completed closure of the duodenum and the protruding pancreatic duct catheter are shown.

U The operative field immediately prior to the closure of the abdominal incision is shown The catheters (14 F) in the common and pancreatic ducts respectively and the Penrose drain in the foramen of Winslow have their exit through the line of closure of the incision rather than separate stab wound drainage sites.

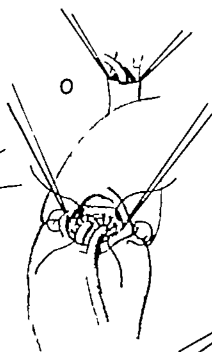
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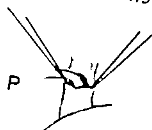
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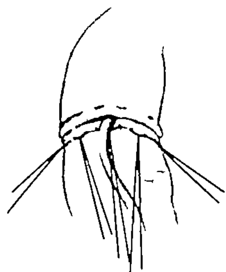
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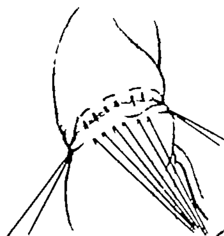
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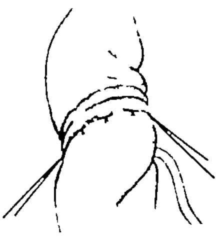
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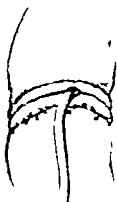
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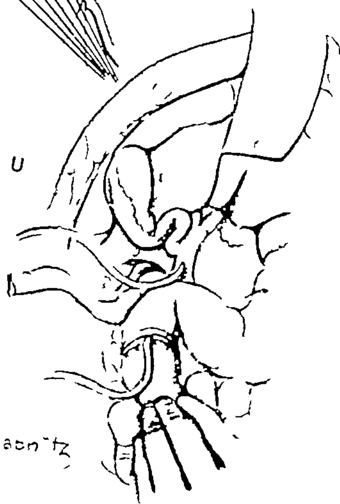
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A. The elliptical incision for removal of the previous operative scar on the palm of the hand is shown in dotted outline. Similarly the incision in the wrist to obtain the palmaris longus tendon as a free graft and the lateral hinge flap incision to expose the digital portion of the flexor tendon are also shown in dotted outline. Prior to making the incisions depicted and following preparation of the operative field, the upper extremity is elevated for approximately three minutes before the inflation of the previously applied tourniquet. A tourniquet is routinely employed in operations upon tendons, with maintenance of the tourniquet pressure at a level of 250 mm. of mercury

B. The elevation of the palmar flap is completed, and the digital flap is being raised by scalpel dissection. The scar tissue mass, incorporated in the distal palmar aspect of the flexor digitorum profundus tendon to the middle finger and the surrounding anatomic structures are visible

C. *Traction is applied to a cotton tape*, which encircles the bridge of tissue in the distal aspect of the palm overlying the flexor tendons of the middle finger to expose the transection of the flexor profundus tendon in the palm proximal to the scar tissue mass. If scar tissue is present in the proximal cut end of the tendon, it is transected farther cephalad until normal tendon tissue is obtained. A sterile tongue depressor is placed beneath the tendon at its site of transection to prevent accidental injury to the subjacent structures.

D The proximal segment of the transected tendon is secured on either side by the insertion of guy sutures of 0000 silk.

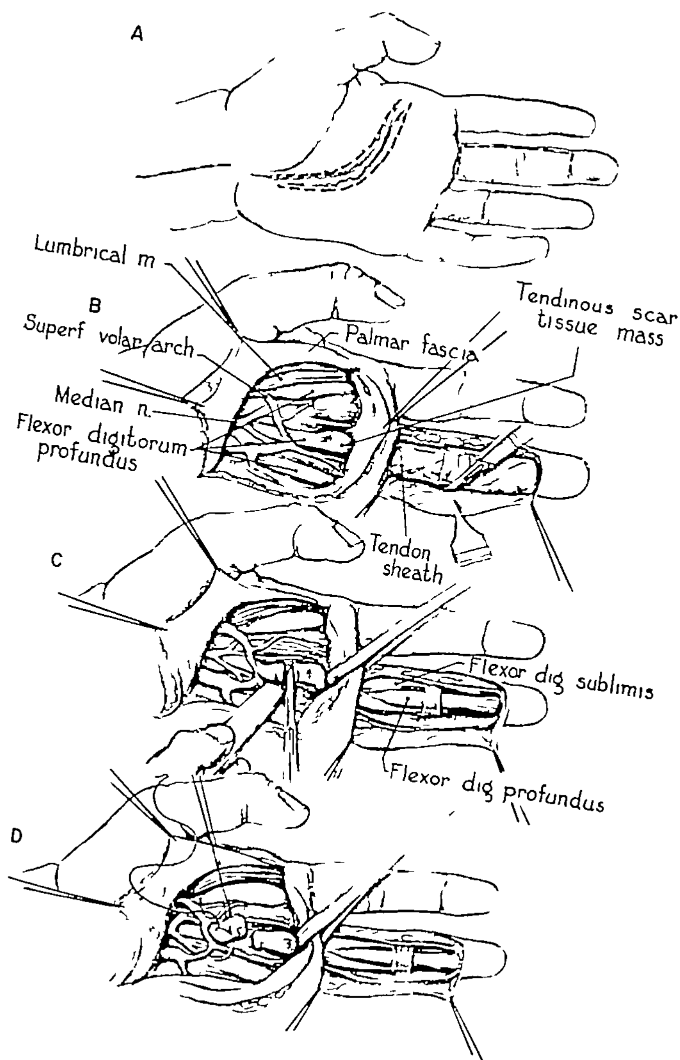
DISCUSSION—DR J WILLIAM LITTLER The successful outcome of a tendon graft used to restore continuity of the disrupted flexor tendon mechanism of the thumb or fingers depends greatly upon the proper selection of cases, strict attention to surgical technic, and postoperative management In general, when both flexor tendons of the finger have been divided in the region of the distal palm or proximal phalanx, a *primary repair often fails because the tendon juncture* becomes incorporated in the surrounding damaged fixed structures and the necessary tendon amplitude for finger flexion is lost. In order to overcome this, it is necessary to resort to a free tendon graft *whereby the tendon junctures can be placed advan*tageously in the soft tissue of the proximal palm and at the terminal phalanx, thereby leaving an intact tendon running through the zone of injury

Prior to the placing of the tendon graft, the interphalangeal joints of the finger should be mobile, good coverage should be present, and sensation should be intact on at least one side of the finger Quite often the sensory nerves are divided together with the flexor tendons In general, when both nerves have been divided, a primary nerve suture is indicated followed by a secondary free tendon graft at a time when sensation has returned to the finger If however only one digital nerve is divided together with the flexor tendons, only the skin at the base of the finger need be sutured, and in the future, when the tissues have softened, a secondary tendon graft can be placed and the one digital nerve sutured

It is essential, as pointed out by Dr Madden, to carry out the secondary tendon grafting in a bloodless field provided through a brachial tourniquet inflated to approximately 250 mm of mercury and maintained for a period of no longer than one-and-one-half hours. Prior to tourniquet inflation, the arm is drained by elevation or through the use of a rubber Martin bandage.

Incisions are of prime importance in the hand, and in general they should be made in the fingers midlateral to the interphalangeal joints and, in the palm, should parallel the flexion creases. However as illustrated, the curved palmar incision can be carried proximally along the inner border of the hypothenar eminence without transgressing the flexion creases at a right angle. The palmaris longus tendon can be re*moved either through two small transverse incisions* made at the wrist and in the midforearm or through a longitudinal incision, as illustrated. However the longitudinal incision, especially in women, is disfiguring.

Exposure of the palmar structures is gained through a division of the vertical septa of the palmar fascia to the ulnar side of the flexor tendon in question. Care must be taken not to damage the neurovascular bundles which lie with the lumbricals between the flexor tendons. The fibrous tendon sheath which extends from the distal palmar crease to the distal interphalangeal crease should be totally resected except for pertinent pulleys which are to be left at the base of the proximal phalanx and in the midportion of the middle phalanx, to prevent bowstringing. A bridge of pulley approximately 0.5 cm. in width is desirable Exposure of the fibrous tendon sheath in the finger can be made through the midlateral incision, as illustrated, carrying the neurovascular bundle with the volar flap or by dissecting the


A
B
C
D
Lumbrical m
Superf volar arch
Median n.
Flexor digitorum profundus
Palmar fascia
Tendinous scar tissue mass
Tendon sheath
Flexor dig sublimis
Flexor dig profundus

E, F By blunt dissection, a clamp is inserted beneath the proximal portion of the digital segment of the flexor digitorum profundus tendon (E), and, by upward traction through the clamp the tendinous scar tissue mass and the distal transected end of the palmar portion of the flexor digitorum profundus tendon are delivered from beneath the overlying bridge of tissue (F) Clamp traction is maintained on the transected end of the tendon just proximal to the scar tissue mass as it is severed distally over an underlying sterile tongue depressor (F).

G. A moist gauze pad is placed in the open wound in the palm of the hand, and the incision on the volar aspect of the wrist and overlying the palmaris longus tendon is being made with a scalpel.

H I. The wound margins are retracted to show a segment of the palmaris longus tendon elevated on a clamp preparatory to its mobilization (H) The distal transected end of the palmaris longus tendon, secured by guy sutures of silk (0000) is retracted upward as the tendon, encased in its shiny and filmy mesotenon, is mobilized proximally by scalpel dissection (I)

Discussion—Dr. Littler (cont.)

digital flap off the bundle The lateral skin ligaments which arise in the region of the interphalangeal joint and attach to the skin are known as Cleland's ligament and must be divided to permit easy entry into the finger The tendon remnants are removed leaving a short stump of the profundus distally and a 1 cm. stump of the sublimis in the region of the proximal interphalangeal joint, to prevent a recurvatum deformity

The palmaris longus tendon is favored as a graft, a toe extensor or a small sublimis tendon, liberated in the palm and withdrawn at the wrist, may also be used. The graft should be sutured proximally to the profundus tendon at the level of the lumbrical muscle, specifically at its distal border This will place the proximal profundus graft juncture deep in the palm in soft tissue The graft is then threaded through the proximal and middle phalangeal pulleys and secured to the stump of the profundus tendon at the terminal phalanx by an end-to-end suture, as illustrated, or secured with a Bunnell pull-out wire into a cortical recess gouged from the ventral cortex of the terminal phalanx between the split profundus tendon stump The pull-out wire is passed through the finger nail where it is secured with a button The proper tension to be placed on the graft is readily determined by placing the finger in question in the functional position with the wrist neutral and adjusting the tension on the graft so that it has just a little more tone than an adjacent normal finger The tendon junctures can be made as indicated with 0000 silk or with stainless steel wire. It is the consensus that 00000 braided wire used at the proximal juncture is less reactive than silk. If a pull-out wire is to be used, No 34 or 35 monofilament stainless steel wire is preferred.

In children end-to-end junctures are made both proximally and distally and no pull-out wire is used. The skin in the very young can be closed with 000000 catgut, making it unnecessary to remove sutures at the end of a three-and-one half to four week period of immobilization. At the end of this period, active exercises on the part of the child can be permitted. Little postoperative care is necessary in the very young In adults, the skin is closed with either silk, nylon, or wire sutures. The hand should be immobilized with the wrist and fingers semiflexed using a dorsal plaster mold. In young children the plaster should be carried above the flexed elbow to insure its remaining in place In the older individual the sutures should be removed on or about the 12th day however there is no urgency to remove either wire or nylon sutures in the hand and they can remain in place during the entire three-and-one-half to four-week period of immobilization, at which time active and passive exercises are started.

It is important for the patient with a free tendon graft to learn the value of immobilizing the proximal phalanx with the opposite hand and directing his effort toward interphalangeal flexion. If the metacarpophalangeal joint is not supported in extension, the adherent tendon graft will flex only this joint and power will not be transmitted distally A good result following a tendon graft is generally manifest by the end of the third month. The results depend to a large degree upon the original condition of the finger the surgical technic, and the effort expended on the part of the patient

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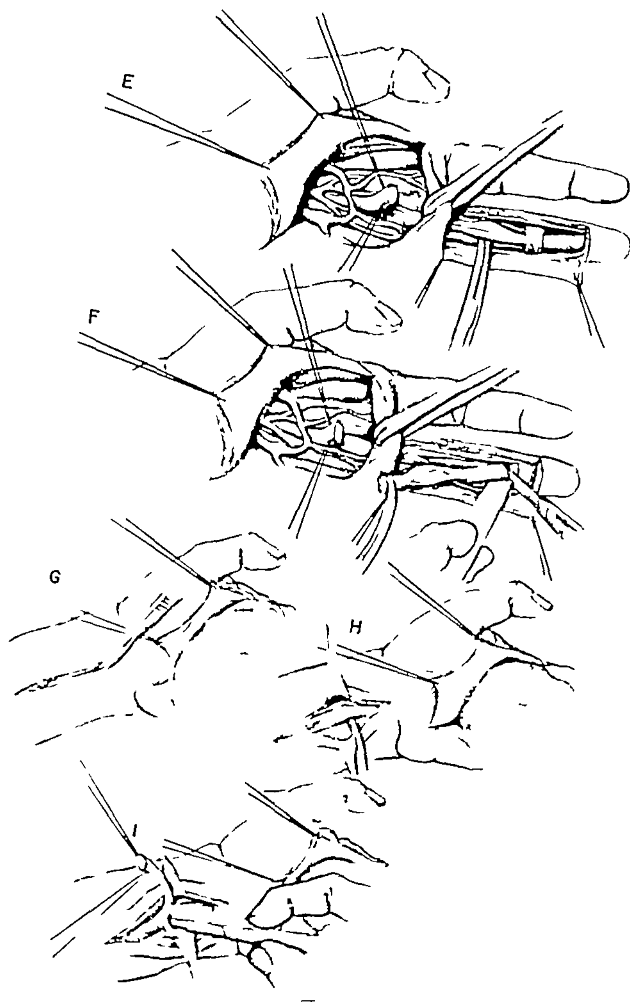
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E
F
G
H
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J J' The transfixion mattress sutures (Bunnell) are inserted in the proximal ends of both the flexor digitorum profundus tendon and the tendon graft. Two of the strands of the opposing sutures are being tied (J) to approximate the ends of the tendons. The inset (J) shows more clearly the completion of the insertion of the Bunnell type of suture employed.

K, L. The transfixion mattress sutures are tied to approximate the proximal end of the tendon graft to the proximal end of the host tendon. The line of approximation is reinforced by interrupted sutures which are first inserted (K) and then tied (L)

M. By use of the long strands of the mattress sutures (a, b) axial rotation of the tendon ends is obtained to allow the insertion of a series of interrupted sutures of silk (0000) posteriorly

N The completion of the anastomosis of the tendon graft to the host tendon proximally is shown.

O In like manner an anastomosis of the tendon graft with the host tendon distally is performed to complete the insertion of the graft. The incised margins of the tendon sheath are being approximated with sutures of silk (0000)

P The closure of the three skin incisions with interrupted sutures of silk (0000) is shown. Following the application of a fluff gauze dressing and a firm but not too tight compressive bandage, a *plaster splint is applied* to the extensor aspects of the forearm, wrist, and hand respectively with the fingers in a flexed position and the forearm midway between pronation and supination. Immobilization in this manner is maintained for a period of four weeks.

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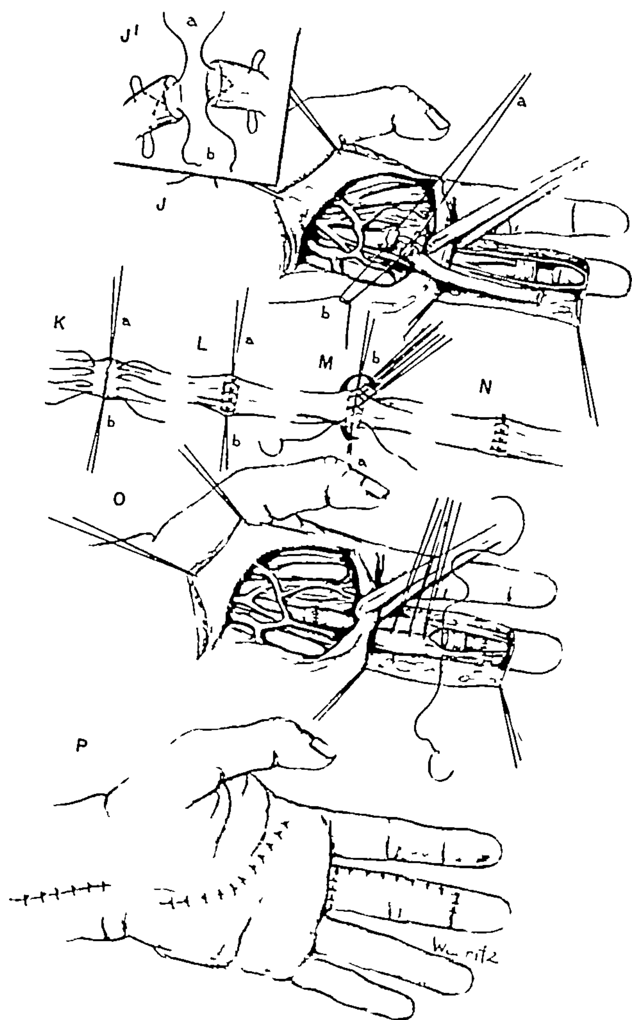
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PATENT DUCTUS ARTERIOSUS

A. The surgical approach for the ligation or severance of the patent ductus arteriosus may be through either an anterolateral or a direct lateroposterior incision as demonstrated. Although both have been used, the lateroposterior originally suggested by Harrington for operations upon the patent ductus, is preferred.

B. The pleural cavity is entered through either the fourth or fifth interspace, preferably the fourth. The visible structures are depicted. The inverted Y incision in the mediastinal pleura, midway between the phrenic nerve anteriorly and the vagus nerve posteriorly is shown in dotted outline

C. The mediastinal pleural flaps are retracted by guy sutures of silk (000) to expose the underlying fibroareolar tissue layer and the vagus nerve which is retracted by an encircling ligature of silk (000) In some instances, although not necessary in this particular patient, ligation and severance of the highest intercostal vein may be required.

D The lappet of pericardium overlying the region of the patent ductus is held taut by a traction suture of silk (000) preliminary to its dissection from the anteromedial surface of the aorta as indicated by the curvilinear dotted line.

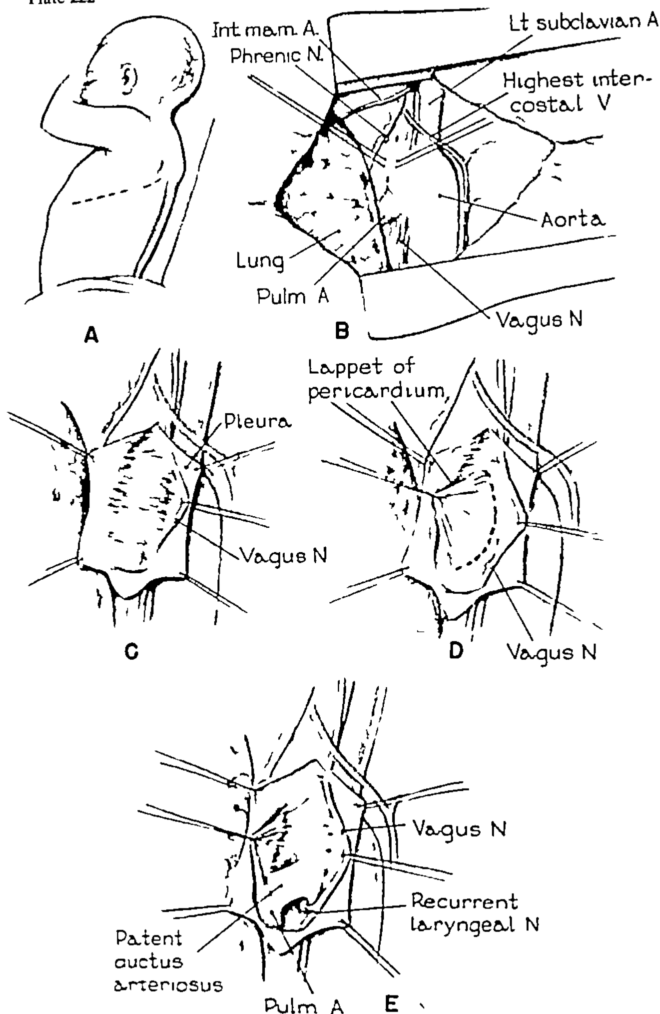
E. The dissection of the pericardial lappet is completed, and the anterior superior and inferior surfaces of the patent ductus are clearly exposed. In this dissection the important landmark for the identification of the ductus is the recurrent laryngeal branch of the vagus nerve, which courses beneath the inferior border of the ductus at its aortic end and then continues upward behind the arch of the aorta into the neck.

DISCUSSION—DR. HERBERT C. MAIER In our opinion, the posterolateral incision is preferable because of the better exposure it affords should any difficulty arise during the intrathoracic manipulations. The upper posterior end of the incision can be kept surprisingly low in children and yet permit ready access to the fourth or fifth interspace; in females, this lower scar may be of considerable cosmetic importance in later life The midportion of the incision should be below the tip of the scapula. An interspace incision without any rib section is adequate in children provided the incision is carried anteriorly to a sufficient extent. The incision in the mediastinal pleura should be made sufficiently posterior to the *phrenic nerve with its vessels in order to avoid the* risk of injury to these structures when the mediastinal pleura is later sutured. Care must be taken that only gentle traction is applied on any temporary encircling thread placed around the vagus nerve. Dissection is best begun over the aorta, as it is easier to identify the proper cleavage plane here. Some surgeons recommend that the aorta be freed in its entire circumference, both above and below the ductus, before dissection of the ductus itself is begun. They advise this so as to permit quick clamping of the aorta if the ductus should inadvertently be torn. This maneuver is not without its own risks an intercostal or bronchial branch of the aorta may be injured in such a dissection. We only employ this technic in special situations where more than the usual risk of ductal injury is anticipated. Patience and gentleness on the part of the surgeon are among the most important factors in avoiding ductal injury during its dissection.

If umbilical tape is employed to obliterate the ductus, it is mandatory that the tape be thoroughly vaselinized so that some vaseline will actually exude as the knot is firmly tied. Otherwise, it is difficult to tell when a tape has been tied sufficiently tight. If this point is carefully observed, tying with umbilical tape can be very satisfactory because two such tapes (one at the aortic and the other at the pulmonary end of the ductus) will give a broad area of ductal occlusion. *The ends of each of the tapes are transfixed* and tied together with a silk suture No metal clips are employed. Thorough closure of the mediastinal pleura is mandatory if umbilical tape is employed otherwise erosion of the projecting knot into the adjacent lung is a possibility We have not seen this occur when the mediastinal pleura is closed. The pleural cavity is routinely drained with a rubber tube which is inserted through a stab wound. The tube is connected for underwater closed drainage.

In cases of patent ductus arteriosus with sufficient pulmonary hypertension to cause possible reversal of flow through the ductus during at least a part of the cardiac cycle, the ductus should at first be clamped with a Potts ductus clamp in order to de-

Plate 222


Int mam A
Phrenic N
Lt subclavian A
Highest intercostal V
Aorta
Lung
Pulm A
Vagus N
A
B
Lappet of pericardium
Pleura
Vagus N
C
D
Vagus N
Vagus N
Recurrent laryngeal N
Patent ductus arteriosus
Pulm A
E

F The ductus is freed posteriorly by blunt dissection with a Mixter type clamp This dissection is facilitated if the index finger of the left hand of the surgeon is inserted above the ductus in the sulcus between the aortic arch and the pulmonary artery In freeing the ductus posteriorly the blunt dissection is maintained toward its aortic end where the tissues are thicker and, accordingly the danger of producing a tear in the ductus is lessened. This complication is most likely to occur during the posterior dissection and usually at the line of junction of the ductus and the pulmonary artery

G The Mixter type clamp is inserted from above the ductus down into the dissected space posteriorly to confirm the completeness of the dissection.

H. A clamp is inserted behind the mobilized ductus preparatory to withdrawing an encircling ligature of No 1 braided silk.

H_1 Inset to show an alternate method of placing the encircling ligature using a malleable ligature carrier with a ball point protective tip This instrument was originally designed for use in operations upon the patent ductus.

I. The ductus arteriosus is occluded with two ligatures of No 1 braided silk, and Cushing silver brain clips are placed on the ends of the ligatures just distal to the knots. These clips serve as a roentgenographic landmark and also prevent the knots of the ligatures from slipping. The use of umbilical tape as a ligature has been discontinued because of the inability to set the knots sufficiently tight to obtain satisfactory obliteration of the ductus

J If preferred the mobilized ductus may be doubly clamped (Potts multitoothed clamps) and severed as indicated. This method, practiced routinely by Gross and Potts, is admittedly the best technic to assure complete and permanent obliteration of the ductus. However with the use of this method, the possibility of technical errors is increased Accordingly double ligation in continuity is preferred as the routine method. However in selective cases, particularly when the ductus is wide in diameter severance of the ductus and suture closure of the divided ends as subsequently shown, is preferred.

K A close up and magnified view of the severed ends of the ductus to show the details of the suture closure as described by Potts

L, M. The closure of the severed aortic end of the ductus is being completed (L) and the relation of the severed and occluded ends of the ductus to the surrounding structures is visible (M).

N. The mediastinal pleura is loosely sutured as demonstrated. The closure of the mediastinal pleura, originally stressed by Jones, is believed an important technical step in the prevention of postoperative complications, particularly aortobronchial fistulas.

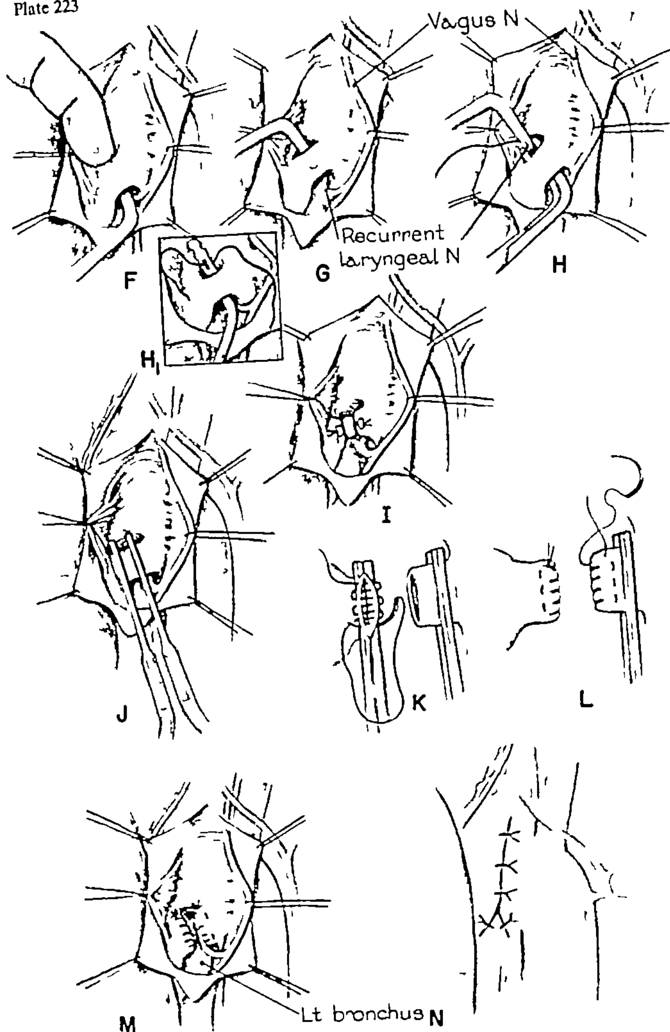
Discussion—Dr. Maier (cont.)

termine whether obliteration of the ductus is tolerated.

When the ductus is to be divided, it is essential that it be thoroughly dissected out so that advantage can be taken of its full length. The ductus appears longer after such dissection. The Potts multitoothed clamps are ideal for ductal division. The clamps should be tested from time to time to ascertain that misuse has not impaired the proper apposition of the fine teeth. The clamps must be placed sufficiently far apart to leave a good cuff of vessel projecting beyond each clamp after the ductus has been carefully transected midway between the two clamps. In order to obtain sufficient distance the clamps may have to "ride up" on the aorta or pulmonary artery An extra set of Potts multitoothed clamps is a highly desirable safety measure in case the original clamps are found to be imperfectly placed after the ductus has been divided.

Failure to obliterate permanently a patent ductus

Plate 223



DISCUSSION—DR. MAIER (cont.)

arteriosus by operation is usually due to either infection or failure to occlude the ductus completely by encircling ligatures or tapes. When recanalization occurs because a ligature cuts through, infection often plays a role, except if transfixion sutures were placed through the ductus itself. We have never employed transfixion sutures, since their use seems unnecessarily hazardous to us.

DISCUSSION—DR. ARTHUR S. W TOUROFF Two surgical approaches are commonly employed in cases of patent ductus arteriosus. The first is anteriorly and extends from the left lateral border of the sternum to the anterior portion of the axilla. The second approach is lateroposteriorly

If an anterior incision is used, its site is best determined by the level of the under surface of the aortic arch as seen in an x-ray film of the chest. With the patient in the supine position, the incision usually is made along the third intercostal space. After the left hemithorax is entered, the third costal cartilage is divided close to the sternum. If additional exposure is required, the second costal cartilage may be divided. In adult females, the incision is made beneath the breast and the latter mobilized upward until the region of the third intercostal space is exposed. The postoperative cosmetic result is excellent.

If the lateroposterior approach is employed, the patient is placed in the right lateral recumbent position. A sweeping subscapular incision is made from the level of the third rib posteriorly and carried *downward and around the angle of the scapula* (Plate 222A) The pleural cavity is entered through the fourth intercostal space after dividing the fourth rib close to its posterior attachment.

Each incision has certain advantages and disadvantages with which the well trained surgeon should be familiar The anterior approach is shorter more direct, divides relatively little muscle tissue and can be performed much more rapidly and with much less bleeding than the lateroposterior approach. Inasmuch as the patient does not lie on the incision following operation, there is apt to be considerably less pain than when the lateroposterior approach is employed. However the surgical exposure of the ductus is not as good The lateroposterior approach requires a long incision, and the scapula must be freely mobilized in order to expose the fourth intercostal space which lies beneath it. In order to accomplish this, a good deal of musculature must be divided. This requires considerably more time, and numerous bleeding vessels must be clamped and ligated Similarly the surgical closure is time-consuming Since the patient frequently lies on his back, the incision is apt to be much more painful postoperatively than when an anterior incision is employed. However the lateroposterior incision provides better exposure of the ductus, especially of its deep or posteromesial aspect. This area and the left branch of the pulmonary artery are the two structures which are most liable to be injured during the process of freeing the ductus from the surrounding structures.

The site of the ductus is best determined at operation by palpating the area in the concavity of the distal portion of the aortic arch. There, a thrill will be felt which is maximal directly over the ductus. Once discovered, firm pressure on the ductus with the index finger will cause the thrill to disappear and the heart to beat more slowly and forcefully The vertical incision in the mediastinal pleura is made between the phrenic and vagus nerves (Plate 222B) and should be about 2 inches long. A few small mediastinal lymph nodes usually are encountered after the mediastinal pleura has been incised. The incision is best made with long, fine scissors. Scissors likewise are employed to incise the pericardial lappet (Plate 222C). Small "peanut" sponges on long artery clamps then are used to free the pericardial lappet from the ductus in a caudad direction A search is made for the recurrent laryngeal branch of the vagus nerve, for this is the most important landmark available for determining the precise position of the ductus (Plate 222E)

From this point on, the surgeon s two most valuable instruments are a pair of fine (¼ inch wide) malleable retractors and a blunt, curved cystic duct clamp *The ductus is freed by repeatedly opening and closing the aforementioned clamp along the superior and inferior surface of the ductus.* The clamp is thus worked slowly beneath the deep aspect of the ductus from above and below As the ductus is freed progressively the fine malleable retractors are introduced to hold the tissues above and below the ductus away from the latter structure. From time to time, counterpressure is made with the left index finger against the tip of the closed clamp as it is slowly advanced behind the ductus (Plate 223F). Sharp instruments such as a scalpel or ligature carrier never should be used in freeing the deep surface of the ductus from the underlying structures (left main bronchus, left branch of the pulmonary artery and recurrent laryngeal nerve).

Once the ductus has been freed completely (Plate 223H), a ligature should be placed around it and the *lumen of the ductus temporarily obliterated.* This maneuver is valuable in determining whether or not the ductus is acting as a necessary bypass for some other congenital cardiac anomaly If it is, the patient will become cyanotic, and, thus, permanent interruption of ductal flow will be contraindicated. Contrariwise, if the patient does not become cyanotic and the heart beat becomes slower and more forceful, ductal interruption may be performed.

The methods of ductal ligation and division illustrated in Plate 223 I J K L, and M are those usually employed and are adequate.

I personally prefer the anterior approach with double ligation of the ductus using heavy braided silk

DISCUSSION—DR. TOUROFF (cont.)

and have found it to be adequate in the vast majority of cases. Should the ductus be unusually short and of large caliber indicating ductal division as the method of choice, the anterior incision can be carried well posteriorly into the axilla to provide adequate exposure for safe ductal division.

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TETRALOGY OF FALLOT

A. The patient is placed in the direct right lateral prone position and a pillow support is inserted between the extended arms The lateroposterior thoracic incision employed is seen in dotted outline.

B. The latissimus dorsi muscle is first mobilized posteriorly and then compressed between the index fingers and thumbs of the surgeon and the first assistant respectively as it is transected (dotted lines) The digital compression is released intermittently for the identification of the severed vessels and the application of clamps for hemostasis. The clamps are subsequently replaced by suture ligatures of 000 silk. This particular technic for the transection of the muscles of the thoracic cage minimizes both blood loss and tissue trauma.

C. The severance of the latissimus dorsi and trapezius muscles is completed, and the underlying serratus anterior and rhomboideus major muscles are visible.

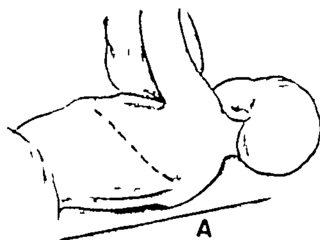
D Prior to the transection (dotted line) of the serratus anterior (serratus magnus) muscle, the fingers of the right hand of the surgeon are inserted beneath the scapula, and the intercostal interspace to be entered (fifth) is identified. This is facilitated by counting downward from the highest rib palpable, the second rib

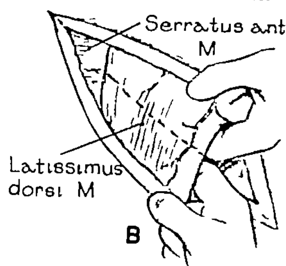
E. The lower half of the periosteum of the fifth rib is removed, and by digital dissection the endothoracic fascia and the pleura are separated from the third, fourth and fifth ribs and the intervening musculature This particular technic, credited to Sir R. C Brock of England, is used almost as a routine in the performance of a thoracotomy It permits an adequate exposure of the intrapleural surgical field without the necessity of resecting a portion of a rib or severing the related intercostal muscle bundle. A portion of a gauze sponge located beneath the erector spinae muscle group is visible

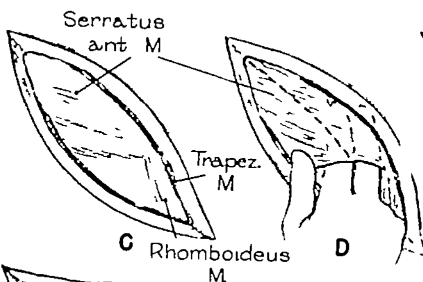
F The fifth rib is retracted upward the site of the incision in the subjacent endothoracic fascia and parietal pleura is indicated by the dotted line

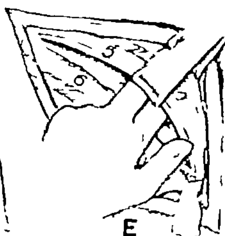
G The left pleural cavity is entered, and the rib margins, covered by protective moist toweling, are separated by a self retaining retractor (Tuffier) to expose the structures as depicted.

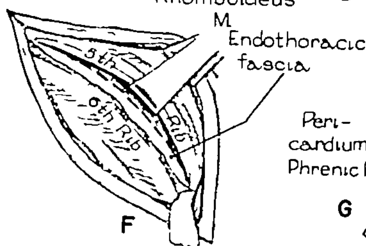
H. The deflated upper lobe of the left lung is covered by a moist gauze protective pad and retracted downward and posteriorly The incision in the mediastinal pleura, which partially encircles the anterior and posterior aspects of the hilum (dotted line), and the related intrapleural structures are demonstrable.

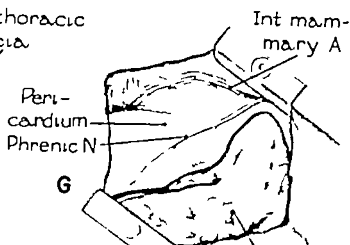

A

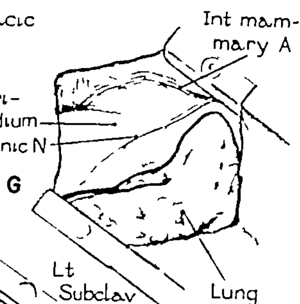

Serratus ant
M
Latissimus
dorsi M
B

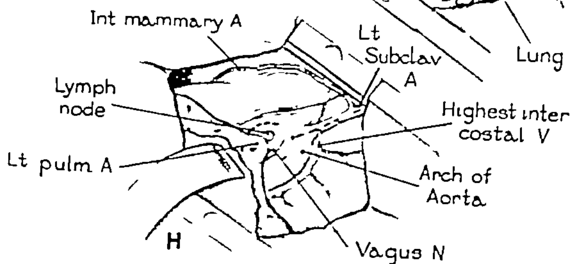

Serratus
ant M
Trapez.
M
C
Rhomboideus
M
D


5
6
E


Endothoracic
fascia
5th
6th Rib
Rib
F


Int mam-
mary A
Peri-
cardium
Phrenic N
G
Lung




Int mammary A
Lt
Subclav
A
Lymph
node
Highest inter
costal V
Lt pulm A
Arch of
Aorta
H
Vagus N

I. In opening the mediastinal pleura, which is now completed, it is usually necessary to ligate doubly and sever the highest inter costal vein The left pulmonary artery mobilized completely about its circumference, is being encircled with a cotton (umbilical) tape The relation of the artery to the sur rounding structures is visible

J The pulmonary artery encircled by two cot ton tapes is displaced medially to expose portions of both the left main stem bronchus and one of the bronchial arteries. The vagus nerve and its recurrent laryngeal branch, which arches upward beneath the lower border of the ligamentum arteriosum at its aortic end and then passes behind the arch of the aorta (dotted line) into the neck, are also visible.

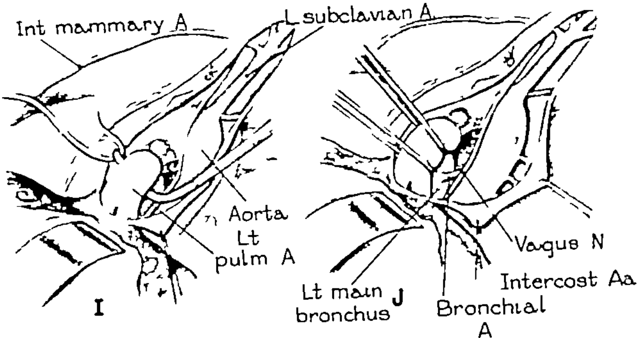
K, L. One of the bronchial arteries, the upper three sets of intercostal arteries, and the branches of the subclavian artery within the thorax are doubly ligated and severed. The ligated ends of a small arterial branch from the base of the subclavian artery may be seen. In this patient, a four and-one half year-old boy an end to-side anastomosis between the left subclavian artery and the pulmonary artery (Blalock) was originally planned However following exploration the subclavian artery was believed too nar row in diameter to effect an adequate shunt, and, accordingly a side to-side aortopulmonic anastomosis (Potts) was the opera tion of choice.

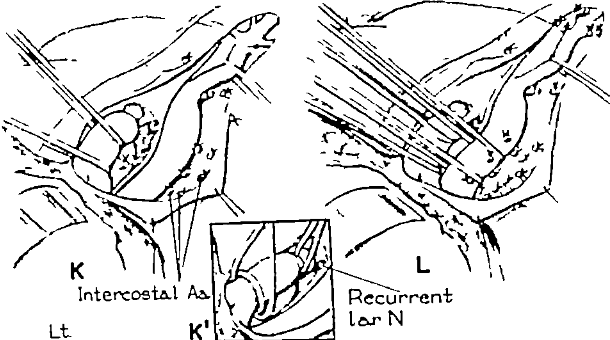
K[1] Inset showing the left pulmonary artery occluded proximally by a double encircling cotton tape ligature A similar ligature, loosely encircling the artery distally may be seen. This ligature will be subsequently tightened by traction to occlude completely the intervening segment of the left pulmonary artery

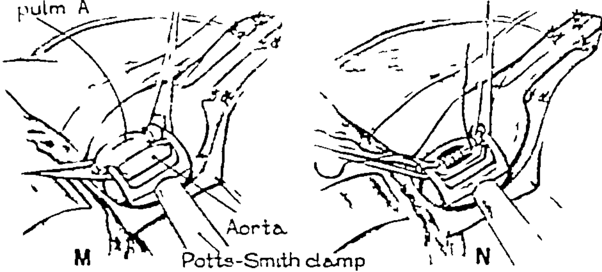
M. The mobilized segment of the proximal portion of the descending aorta is partially occluded in a Potts-Smith clamp and approximated to the occluded segment of the left pulmonary artery To maintain approximation, one strand of each of the occluding tape ligatures on the pulmonary artery is passed beneath the metal bar on either end of the jaw of the clamp, and, by traction on the tapes, both the arterial occlusion and the approximation of the vessels are ade quately maintained. If preferred, the liga ture strands may be tied to the jaws of the clamp The sites of the incisions in the oc cluded segments of the aorta and the pul monary artery are shown in dotted outline. The length of each of the incisions measured by a caliper is 6 mm. It is important not to make the anastomotic stoma too large, and yet it must be adequate in size to be effective

N The openings into the lumen of the aorta and the pulmonary artery are made, and the insertion of the posterior suture layer is completed. A continuous over and over su ture of 00000 arterial silk, which starts from the "outside in" on the aorta and terminates from the "inside out" on the pulmonary ar tery is used

Plate 225


Int mammary A
L subclavian A
Aorta
Lt
pulm A
I
Vagus N
Intercost Aa
Lt main
bronchus
J
Bronchial
A


K
Intercostal Aa
K'
Recurrent
lar N
L

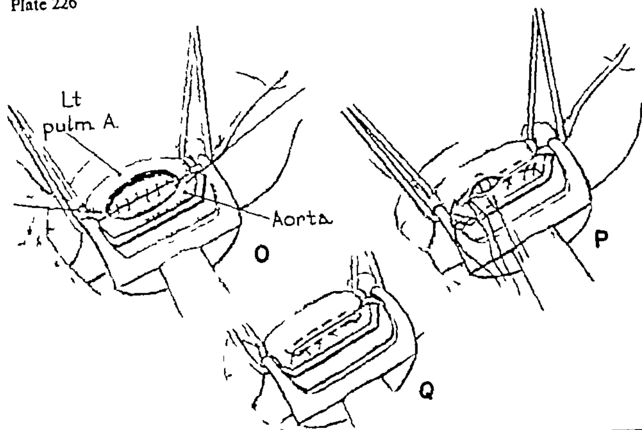

Lt
pulm A
Aorta
M
Potts-Smith clamp
N

O Close up view of the completed posterior layer of the anastomosis. The presence of the line of sutures within the lumen of the blood vessels, though theoretically objec tionable has not produced any untoward symptoms.

P, Q Close-up views of the anterior layer of the anastomosis during (P) and following its completion (Q) A series of interrupted everting mattress sutures of silk (00000) is used for the closure of the anterior layer If desired either a continuous over and over or everting type of suture may be employed. At either end of the anastomosis one of the strands of the adjacent mattress suture is tied to the free end of the suture forming the posterior layer

R^1 R^2 R^3 R^4 These close up views illustrate an actual occurrence during the performance of an aortopulmonic anastomosis (Potts) Accordingly it is believed that it may be of technical surgical interest. Follow ing the completion of the posterior layer of the anastomosis it was observed that the central portion of the anterior lip of the in cised aorta had slipped beneath the upper blade of the Potts Smith clamp (R) This technical difficulty was dealt with satisfac torily by first occluding the aorta completely both proximally and distally to the site of the anastomosis with angulated Potts ductus clamps (R^2) The Potts-Smith clamp was then quickly removed, and a series of simple interrupted sutures of silk (00000) were inserted (R^2) and drawn taut (R^3) The *Potts–Smith clamp was then reapplied, and* the angulated ductus clamps occluding the aorta were removed (R^3). Subsequently the anterior layer of interrupted sutures was tied to complete the anastomosis (R). In this patient the total time of complete aor tic occlusion was six minutes. The conva lescence of the patient was uneventful.

Plate 226



R1

R2

R3

R4

If both the diameter and the length of the subclavian artery are adequate in size it may be used for an anastomosis to the pulmonary artery (Blalock technic) In fact, if given a choice, this method is preferred to the performance of a side-to-side anastomosis between the pulmonary artery and the aorta (Potts technic). Although the use of the right subclavian artery has been advocated by Blalock because of the unobstructed arch it forms with the innominate, the use of the left subclavian artery is preferred. Technically the left subclavian artery is easier to mobilize and the objection to the angulation that occurs at its origin from the aorta is believed more theoretic than real.

S. The proximal portion of the left pulmonary artery is occluded with a Blalock clamp and a Potts angulated ductus clamp is applied across the base of the left subclavian artery the branches of which have been previously ligated and severed. The subclavian artery is occluded distally by a ligature of silk (0) immediately proximal to which a transfixion suture ligature is being inserted The site of transection of the subclavian artery is indicated by the dotted line

T The proximal transected end of the left subclavian artery is turned downward toward the pulmonary artery which is doubly encircled distally by a cotton tape that will be used subsequently to occlude completely the lumen of the pulmonary artery The site for the incision into the lumen of the pulmonary artery is shown by the dotted line

U U[1] The insertion of the continuous over and over suture (00000 silk) posteriorly is completed, but it is not drawn taut This suture starts from the "outside in" at the proximal end of the opening in the pulmonary artery and terminates from the "inside out" at the lateral angle of the transected proximal end of the left subclavian artery If preferred, a continuous everting mattress suture may be used (U) This suture starts from the "outside in" at the medial angle of the proximal transected end of the subclavian artery and finishes from the "outside in" at its lateral angle

V The posterior suture is drawn taut to complete the posterior layer of the anastomosis and the insertion of the everting interrupted mattress sutures anteriorly is begun.

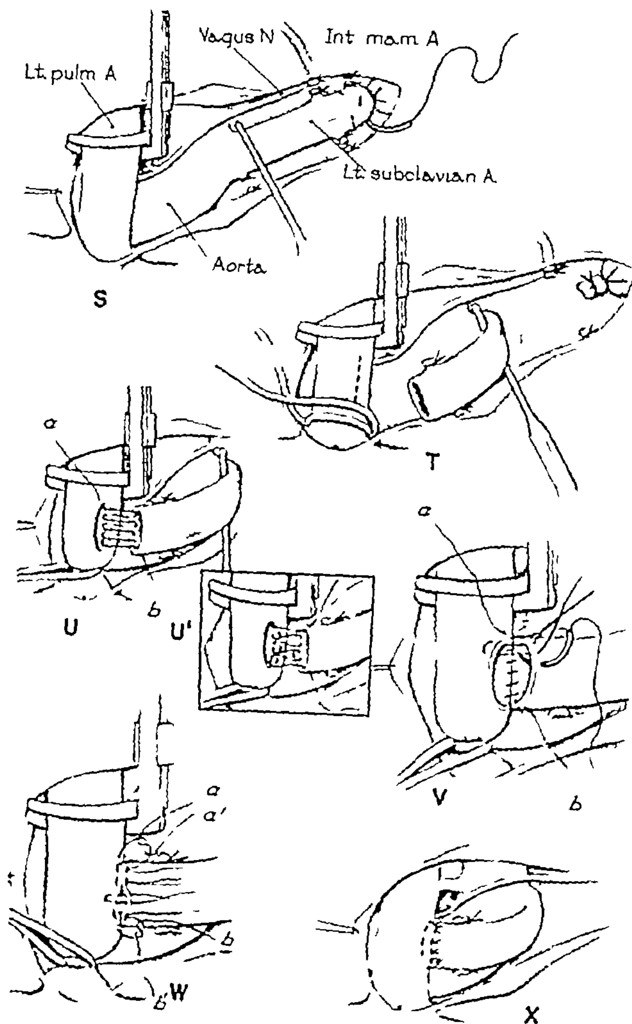
W The insertion of the interrupted mattress sutures which form the anterior layer of the anastomosis is completed, and all but one are tied. At either angle of the anastomosis, one of the strands of the adjacent mattress suture anteriorly is tied to either free end of the continuous suture posteriorly (a, a[1] and b b).

X The completed end to-side anastomosis of the left subclavian artery to the side of the left pulmonary artery is depicted Although the angulation of the left subclavian artery at its site of origin from the aorta is theoretically objectionable, the clinical results obtained with its use have proved satisfactory

DISCUSSION—DR. ALFRED BLALOCK. *Anesthesia.* The patient should not be deeply anesthetized. Control of respiration greatly facilitates the operation. The use of hypothermia is rarely indicated

Incision If a subclavian-pulmonary anastomosis is planned, an anterolateral incision is used. The pleural cavity is entered through the second or third interspace- the second is preferred If an aortic-pulmonary anastomosis is planned, a posterolateral incision is used The anterior incision has the advantage of interfering less with respiratory function.

Choice of systemic artery In approximately 25 per cent of patients with the tetralogy of Fallot, there is a right aortic arch. In such patients the innominate is on the left instead of the right. Since we prefer when possible to use the subclavian that arises from the innominate the incision generally is made on the right when there is a left arch and on the left when there is a right arch. At times we use the subclavian that arises directly from the aorta but much


Vagus N
Int mam A
Lt. pulm A
Lt. subclavian A
Aorta
S
T
a
U
b
U'
a
V
b
a
a'
b
b'
W
X

Y The relation of the completed end to-side anastomosis between the left subclavian artery and the left pulmonary artery (Blalock operation) to the surrounding structures in the operative field is visible.

Y[1] The same field as in Y after closure of the mediastinal pleura.

Z. The relation of the completed side-to-side anastomosis between the aorta and the left pulmonary artery (Potts operation) to the adjacent structures is shown. The previously isolated left subclavian artery which at operation was considered too narrow in diameter to use, may be seen. It was this finding which indicated the performance of the Potts rather than the Blalock procedure

DISCUSSION—DR. BLALOCK (cont.)

prefer that arising from the innominate. Sharp angulation is thereby avoided.

There are some exceptions to the following general statements. In children between the ages of 2 years and 12 years, an end-to-side anastomosis is *performed between the subclavian branch of the in*nominate artery and the pulmonary artery In infants the Potts aortic-pulmonary anastomosis is usually used because the subclavian is too small. In patients over the age of 12 years, the subclavian branch of the innominate may be too short, and we usually use the Potts type or the subclavian branch of the aorta.

Size of anastomosis. When using the subclavian artery one need have little fear of causing heart failure. When using the aortic-pulmonary anastomosis one should not make the opening more than 5 or 6 mm. in diameter or heart failure is apt to follow We have the impression that a subclavian-pulmonary anastomosis of a given size is less apt to cause heart failure than an aortic-pulmonary union of the same size.

Bilateral operation. In approximately 110 of our 1500 patients with Fallot's tetralogy or some variation of it, a second operation on the opposite side has been performed. The indications have been closure of the first anastomosis or inadequacy of the shunt associated with growth of the patient If the first operation consisted of a shunt between the right *subclavian and pulmonary arteries, the second op*eration consists of an anastomosis between either the aorta or the left subclavian and the left pulmonary artery If the patient has a right aortic arch and the first operation consisted of a shunt between the left subclavian and left pulmonary arteries, in performing a second operation on the right, one may have to use a graft in connecting the aorta with the right pulmonary artery

Open heart surgery When the operative mortality is reduced further and when the results of a longer follow-up period become known, it is likely that the direct open attack will largely replace the shunt procedures except in cases of tricuspid atresia, pulmonary atresia, and similar situations. The likelihood that this will occur is a point in favor of subclavian-pulmonary anastomosis rather than aortic-pulmonary anastomosis because the former can be closed more readily if it is advisable to do so in the future.

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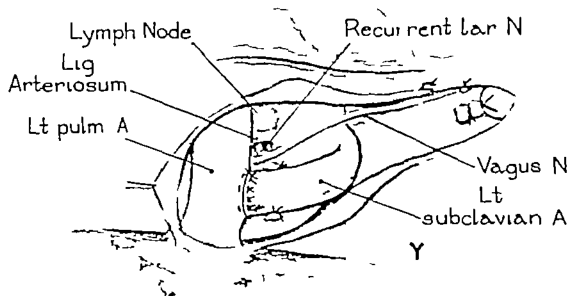
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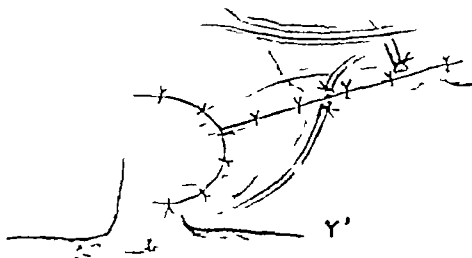
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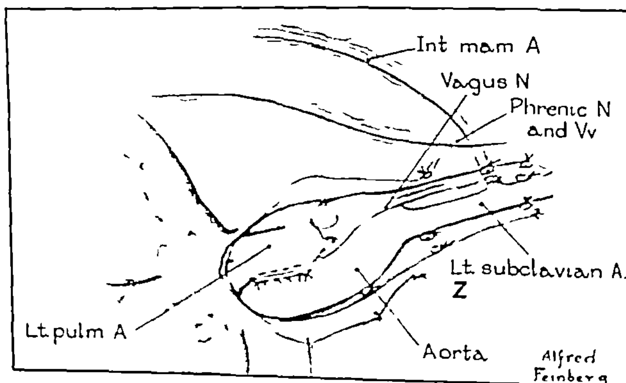
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Lymph Node
Recurrent Lar N
Lig Arteriosum
Lt pulm A
Vagus N
Lt subclavian A
Y


Y'


Int mam A
Vagus N
Phrenic N and Vv
Lt. subclavian A
Z
Lt. pulm A
Aorta
Alfred Feinberg

A. The patient is placed in the direct right lateral prone position, and the site of the left thoracotomy incision is outlined and cross-hatched to facilitate later closure.

B C. The incision is deepened through the subcutaneous fat and fascia to expose the underlying musculature and the accompanying large collateral blood vessels

D E. The trapezius and latissimus dorsi muscles respectively are compressed between the thumbs and index fingers of the surgeon and first assistant, and the muscle fibers are severed with a scalpel. The muscles are incised for only short lengths at a time, and as the digital compression is released, bleeding points are identified and clamped Hemostasis is then secured with suture ligatures of silk (000) This method for severance of the muscles prevents excessive blood loss and its use is believed mandatory in all thoracotomies performed for coarctation of the aorta.

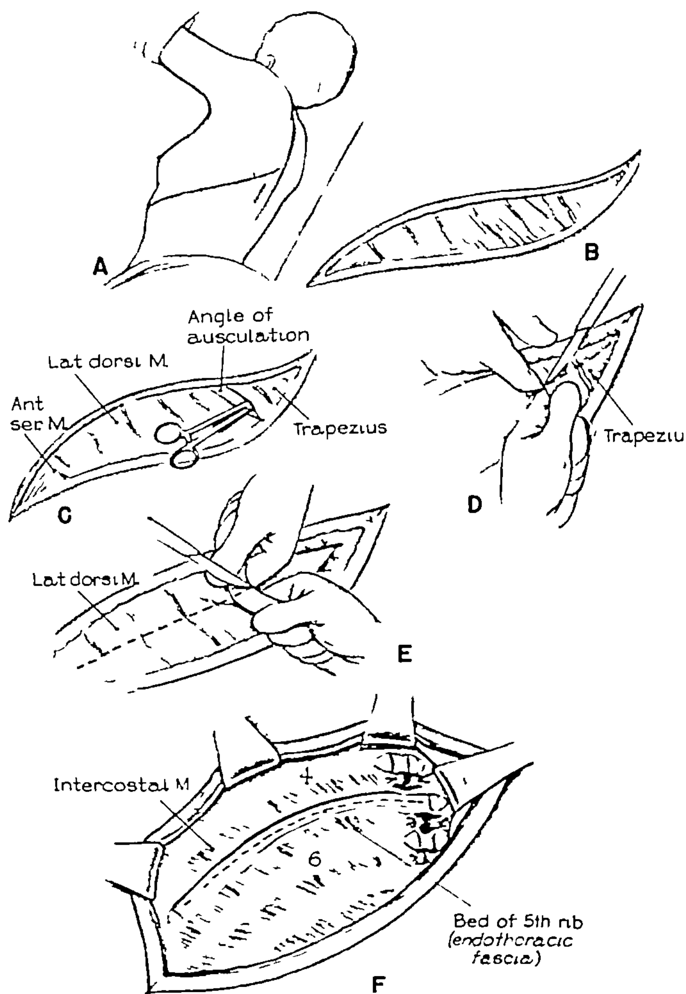
F A subperiosteal resection of a long segment of the fifth rib and short segments of the fourth and sixth ribs is performed The intervening intercostal bundles are clamped, severed, and ligated with suture ligatures of 00 silk. The incision in the bed of the resected fifth rib is depicted by the dotted line. In some instances resection of a long segment of the fourth rib and short posterior segments of the third and fifth ribs may prove more desirable.

DISCUSSION—DR. RALPH A. DETERLING JR. In general, I have favored a curved incision for high thoracotomies For repair of coarctation my incision begins horizontally passing about 1 cm. below the tip of the scapula and curving cephalad between the scapula and the spinous processes of the thoracic vertebrae Because of the very large subcutaneous collateral arteries, I develop the skin incision in lengths of about 10 cm securing bleeding vessels before continuing In this way blood loss may be minimal

Regarding the division of the muscles of the chest wall in these patients, I personally prefer not to introduce instruments or fingers blindly beneath the muscles (Plate 229C D E) I have seen very troublesome bleeding occur because of injury to the dilated, thin walled arteries entering the muscles from the chest wall. I prefer to cut the muscle with a gentle sawing action, deepening the incision slightly with each stroke. The arteries to the muscles may be readily observed before being cut and can be secured with clamps without blood loss The slight extra expenditure of time is compensated for by the loss of only minimum quantities of blood.

I have generally resected only the fourth rib subperiosteally In contrast to the method of standard thoracotomy I do not separate the erector spinae muscle group from the posterior segment of the rib until the rib is completely freed from periosteum elsewhere. If the large perforating posterior branch of the intercostal artery is then opened inadvertently the rib can be removed at once for better exposure and the control of hemorrhage I have been satisfied with the use of ligatures of 0000 and 000 silk.

Plate 229


A
B
Angle of ausculation
Lat dorsi M
Ant ser M
Trapezius
C
Trapezu
D
Lat dorsi M
E
Intercostal M
4
6
Bed of 5th rib (endothoracic fascia)
F

G The wound margins and rib cage are separated with two self retaining (Tuffier) retractors, and the operative field is exposed. An incision is made through the pleural covering of the aorta, and its cut margins are retracted by guy sutures of silk (0000) to show more clearly the underlying highest intercostal vein and the surrounding fibroareolar tissue layer

H I. The incision in the pleura is extended, and the highest intercostal vein is doubly ligated and severed. The dissection of the surrounding fibroareolar tissue is completed to demonstrate the coarcted segment of the aorta and its related structures The poststenotic dilatation of the aorta and the enlarged intercostal arteries are visible In this particular patient there were two branches from the segment of the aorta proximal to the site of the coarctation.

J Inset showing the ligated stumps of two of the severed intercostal arteries and the insertion of a transfixion suture of silk (000) in the uppermost and largest of the three intercostal arteries. The site of severance of this artery is indicated by the dotted line Clamps are not used because of the frequent friability of the vessels Every precaution should be taken to secure adequate hemostasis and prevent the excessive bleeding that may accompany the slipping of a ligature. If hemorrhage should occur from a severed intercostal artery the best method for hemostasis is for the surgeon to insert the index finger of the left hand behind the aorta, the circumference of which is always mobilized prior to ligation and severance of the intercostal vessels, and compress the aorta between the thumb and the index finger about the site of the hemorrhage. The operative field is then cleared of blood by irrigation with saline solution and suction siphonage The bleeding site is visualized and hemostasis is obtained with suture ligatures of arterial silk (00000) swedged on a minimum trauma needle Preservation of the collateral pathways through the enlarged intercostal arteries is frequently stressed, but the necessity for this is questioned if resection of the coarcted segment and restoration of aortic continuity either by direct anastomosis or the insertion of a graft, is feasible.

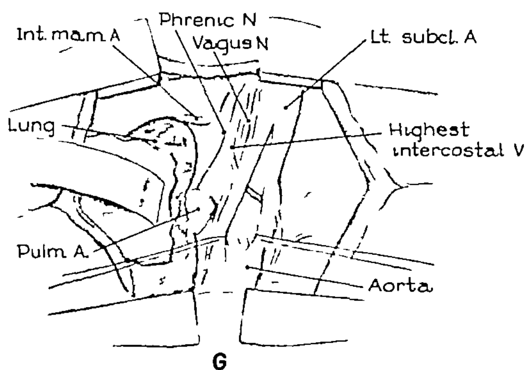
K. The uppermost paired intercostal arteries and the bronchial arteries are ligated and divided, and the aorta, the coarcted segment, and the subclavian artery respectively are encircled with umbilical tapes. As mentioned previously this is done prior to ligation and division of the intercostal arteries to facilitate the control of bleeding should hemorrhage occur The relation of the recurrent laryngeal branch of the vagus nerve to the inferior surface of the ductus arteriosus (patent in this patient) is demonstrated. The operative field is now in readiness for division of the ductus arteriosus and resection of the coarcted segment of the aorta.

DISCUSSION—DR DETERLING (cont.)

I have found two Tuffier retractors (Plate 230G) difficult to keep in place, even with double thickness pads over the rib edges. Not infrequently one is opened wider than the other or else they angulate during the operative procedure A single Burford retractor with a large blade above and small blade below has been simpler to keep in proper position in the midportion of the wound

The author has done well to point out the variation observed in the minor aortic branches (Plate 230 H I) On occasion a branch passes posteriorly from the dilated subclavian artery at its origin and can be easily damaged during the mobilization of the subclavian artery

I agree heartily with the author's admonition against the use of clamps on the intercostal arteries (Plate 230J K). These friable arteries easily pull out of the wall of the aorta with merely the weight of a hemostat. Prior to the division of the first set of intercostal arteries and bronchial arteries (Plate 230J K, Plate 231L), I have preferred to perform first the step subsequently described by the author (Plate 231M).



Vagus N

Coarcted segment

Pleura

H

I

Recurrent laryngeal N

Ductus arteriosus

Intercostal arteries

J

Bronchial arteries

K

Paired intercostal arteries

L. The thoracic aorta below the coarctation is rotated on its longitudinal axis, and the ligated stumps of the paired intercostal arteries are demonstrated.

M. The patent ductus arteriosus is isolated and doubly clamped prior to its division. The recurrent laryngeal nerve curves upward and passes inferior and posterior to the aortic end of the ductus. Its preliminary exposure provides an important landmark for the identification of the ductus Furthermore, in the application of clamps and ligatures to the ductus one must be careful to avoid injury to this nerve.

N. The coarcted segment is completely mobilized and Potts multitoothed straight clamps are applied across the aorta above and below the area of coarctation. The extent of the resection is indicated by the dotted lines In the resection of the area of coarctation it is most important to remove a sufficiently long segment, both proximally and distally to assure an adequate size of the aortic lumen upon completion of the anastomosis. However if after the resection a direct anastomosis cannot be performed without undue tension on the suture line, a graft or prosthetic replacement should be employed. The use of a graft should always be considered in the older adults in whom extensive arteriosclerosis and concomitant friability of the aorta may be present.

O The posterior suture layer of the anastomosis is inserted. This is a continuous eversion type of suture (silk, 00000) with intima to intima approximation. The suture is commenced from the "outside in" on the proximal segment of the aorta and terminates from the "inside out" also on the proximal segment of the aorta Between its commencement and termination, the suture proceeds from the "inside out" to the "outside in" relative to the lumen of the aorta. Accordingly the loops formed by the suture are always on the outside of the lumen.

P The posterior suture a–a is drawn taut, and the intimal surfaces of the aortic segments are brought into close approximation. None of the silk suture is exposed within the lumen. The anterior layer of the anastomosis is commenced by the insertion of interrupted everting mattress sutures of silk (00000) at either angle of the anastomosis.

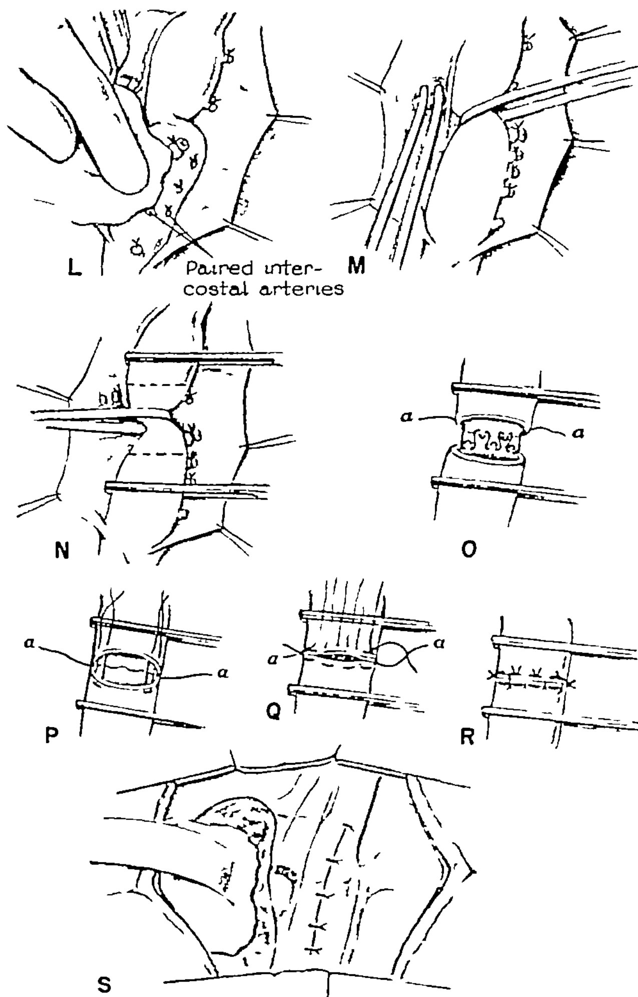
Q. The remaining interrupted everting mattress sutures are inserted anteriorly but not tied. The mattress sutures at either end are tied first, and one of the long ends of each of these sutures is in turn tied to either end, a–a, of the continuous everting suture of silk used for the posterior layer

R. The intervening everting mattress sutures are tied to complete the anastomosis. Simple interrupted sutures are inserted between the mattress sutures to reinforce the closure.

S. The operative field following completion of the operation is depicted. The site of the aortic anastomosis may be seen in dotted outline beneath the line of closure of the incision in the pleura overlying the aorta.

Discussion—Dr Deterling (cont)

That is, after mobilizing the subclavian artery and securing it with a double loop of narrow braided cotton tape, I pass a similar loop about the arch of the aorta proximal to the ductus arteriosus for hemostatic control I next develop the plane behind the aortic arch and region of the coarctation, and about the ligamentum arteriosum. The ductus arteriosus has been patent in only 15 per cent of my cases. I divide the ligamentum or ductus before mobilizing the dilated, friable aortic branches distal to this area because, if serious bleeding occurs while securing *these branches, control can be effected simply by* cross-clamping the mobilized aorta with two Potts coarctation clamps and dividing it With the distal *end elevated gently and rolled on itself slightly the* bleeding site can be easily and safely repaired with 00000 braided silk swedged on a taper point needle. The blind introduction of instruments or fingers beneath the aorta during its mobilization can lead to very serious and at times fatal hemorrhage. In dividing the ligamentum arteriosum (Plate 231L, M, N), I generally pass lengths of 00 silk about it, tying them at the aortic and pulmonary artery ends respectively before dividing it. If there is a patent ductus arteriosus, I place Potts ductus clamps on the aortic and pulmonary artery ends of the ductus, and after dividing it with a knife, oversew the ends with a continuous suture of 00000 braided silk.


L
Paired inter-
costal arteries
M
N
a
a
O
a
a
P
a
a
a
Q
R
S

This plate depicts alternate methods for the resection of a coarcted segment of the aorta and the restoration of aortic continuity

A A[1] A[2] A[3] A[4] These illustrations demonstrate a high-lying coarctation in which mobilization of the aortic arch and cross-clamping of the arch and the left subclavian artery are required preliminary to resection and direct anastomosis

B B[1] In the presence of a long coarcted segment of the aorta, a resection and primary anastomosis is impossible. Accordingly a graft is required to restore aortic continuity This method is frequently employed in the older adults in whom the arteriosclerotic changes present may preclude a direct anastomosis It is also preferred to the use of the proximal end of the severed left subclavian artery

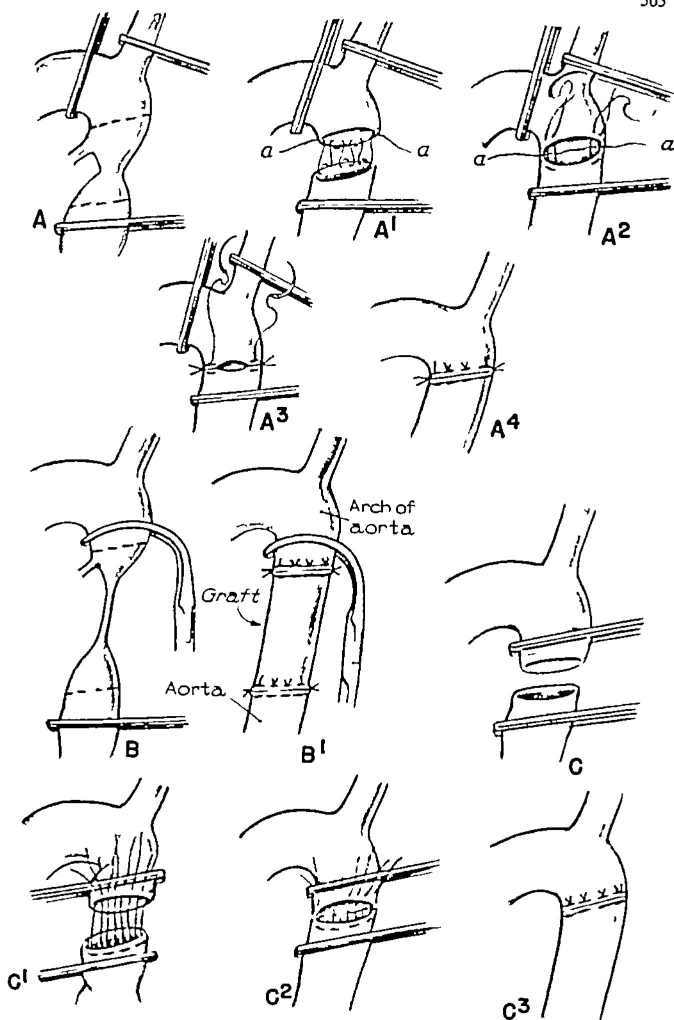
C C[1] C[2] C[3] This series of drawings depicts the technic originally described by Gross and Hufnagel for direct aortic anastomosis following the resection of the coarcted segment. The cut ends of the aorta are rotated on their longitudinal axes, and a series of interrupted everting mattress sutures of silk (00000) are inserted posteriorly (C). The aorta is then derotated, and the anterior layer of interrupted everting mattress sutures of silk (00000) is inserted (C[2]) to complete the anastomosis (C[3]).

Discussion—Dr. Deterling (cont.)

When there is a moderate disproportion of the opposed aortic ends (because of hypoplasia of the proximal segment or poststenotic dilation of the distal segment), the use of everting mattress sutures reinforced with interrupted sutures is a very secure anastomosis (Plate 231O P Q R) However in most adult cases, I employ a simple continuous suture of 00000 braided silk. In infants I have used interrupted mattress sutures of 0000 chromic catgut with maximal growth as the goal. As an alternate method for infants, a simple continuous suture may be used for the posterior row with interrupted sutures anteriorly (Johnson and Kirby) If even after dividing additional intercostal arteries, there is tension on the aorta while approximating the ends, I have placed the posterior continuous suture from within the aorta This obviates the need for rotating the vessel and risking additional damage from the use of clamps

Instead of two straight clamps (Plate 232A, A A A A), a Potts-Beck clamp may be used as shown in Plate 233C. Circulation may thus be maintained from the aorta into the left subclavian artery and its collateral branches. In rare instances the coarctation may lie between the left common carotid artery and subclavian artery In such instances the use of multiple straight clamps may be necessary

I agree that a graft (Plate 232B B) is indicated when a long stenotic segment is found. Since this cannot always be predicted, the surgeon should have available a graft for immediate use in all cases of coarctation in adults. In infants and children, an effort should be made to avoid the use of a graft which would not grow at a pace equal to that of the host vessel. By dividing additional intercostal arteries, enough length may be gained in most, if not in all, of the cases


a
a
a
a
A
A1
A2
A3
A4
Arch of aorta
Graft
Aorta
B
B1
C
C1
C2
C3

A B. In those instances in which the length of the coarcted segment precludes a direct anastomosis (A) and in lieu of a homologous aortic graft replacement or cloth prosthesis, the proximal end of the severed *subclavian artery may be anastomosed to* the distal severed end of the aorta (B) as originally suggested and practiced by Clagett.

C. In the presence of a high-lying coarctation of the aorta, the proximal or uppermost clamp one of the Beck-Potts type may be applied tangentially to occlude only partially the lumen of the aortic arch and the *left* subclavian artery

DISCUSSION—DR. DETERLING (cont.)

Although I assisted Clagett in his performance of the first subclavioaortic anastomosis in a patient with coarctation (August 6, 1946) and subsequently performed the same operation myself in patients with long stenotic segments at the time when grafts were not available the final hemodynamic results have not generally been so good as those observed with end-to-end aortic anastomosis or with the use of an aortic homograft. However I could conceive of this operation still serving a purpose in a young patient with a long stenotic segment (possibly as an interim procedure) or if graft material was unobtainable (Plate 233A, B). Usually the subclavian artery has a greater diameter than that depicted by the artist.

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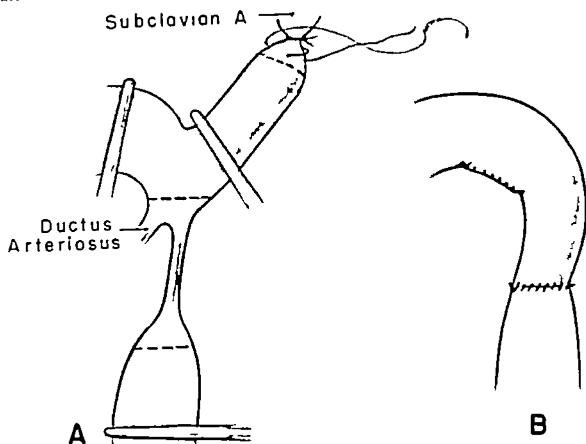
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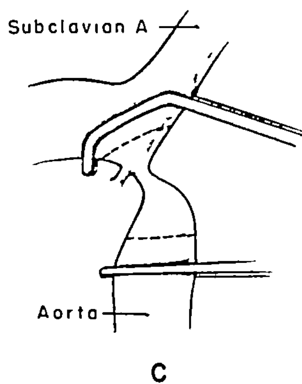
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Plate 233





A. The left side of the thorax is elevated slightly on a pillow and a *transverse curvilinear inframammary incision* is depicted.

B. The mammary gland is elevated the line of incision through the pectoralis major and serratus anterior muscles is shown in dotted outline.

C. The incised muscle layers are retracted, and the underlying fourth rib and adjacent intercostal muscles are visible.

D. The cephalad portion of the pectoralis major muscle is retracted upward to expose the pectoralis minor muscle, the angulated incision in the third costal cartilage, the partially *resected fourth costal cartilage*, and the line of incision in the fourth interspace

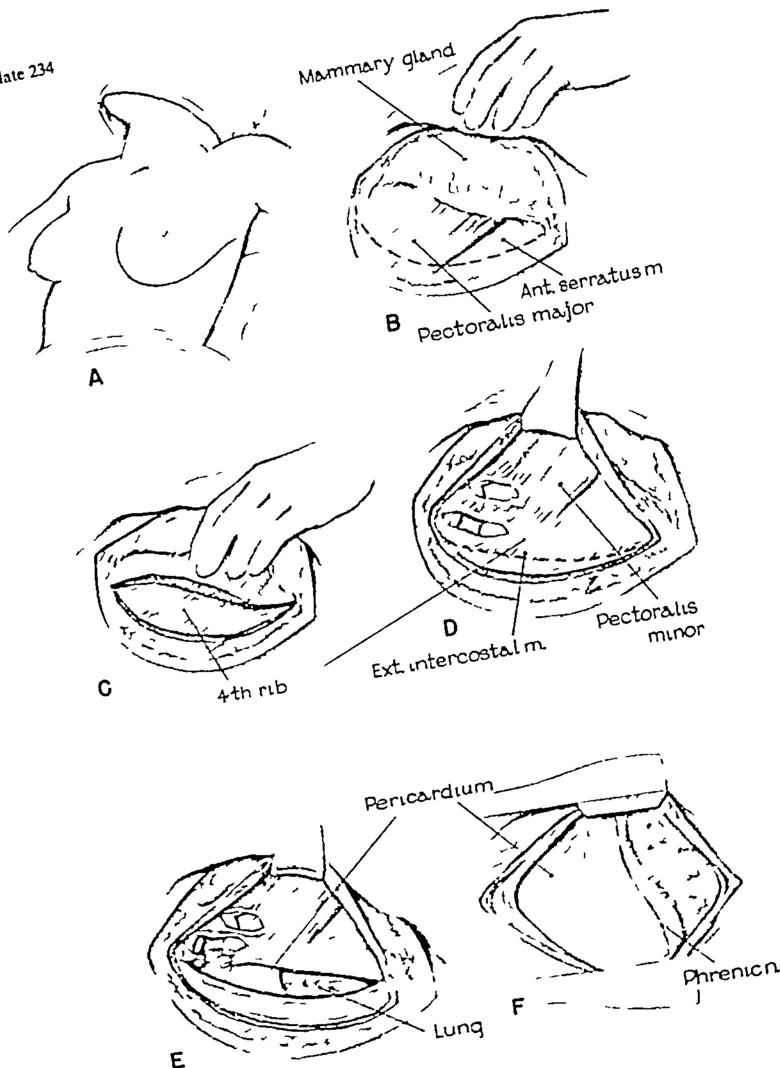
E. The left pleural cavity is entered, and the intercostal neurovascular bundle subjacent to the fourth costal cartilage is doubly clamped, severed, and ligated. Portions of the pericardium and left lung may be seen.

F The fourth and fifth ribs and the adjacent wound margins are retracted with a self retaining retractor to expose more completely the underlying pericardium and adherent left lung.

DISCUSSION—DR. GEORGE H HUMPHREYS, II. A congenitally stenosed pulmonary valve may be opened either by the closed method devised by Brock and depicted in Plates 234 through 236 or by the open method advocated especially by Swan and demonstrated in Plate 237 Although each method is well illustrated, it should be noted that, even with the transverse double thoracotomy incision (Plate 237A), exposure of the heart and great vessels is not as complete as the illustration implies When the valve is exposed in the open procedure remnants of commissures may be seen and the surgeon may elect to restore a tricuspid valve rather than to make a simple tran verse incision as illustrated (Plate 237). the
valve is irregularly distorted, care must be
avoid creation of incompetence The valv
is frequently stenotic and will require dil
the open as well as in the closed procedure

Consideration of the relative advantages and disadvantages of each method is important The closed method of Brock is the older and there is a tendency among many recently trained surgeons to consider it obsolete. However it has the advantage of greater simplicity and, when properly done in the appropriate cases, its results are equally good. Although published series do not show a greater mortality in the open procedure there is no question that the need for bilateral thoractomy and hypothermia or extracorporeal circulation add considerably to the risk of the operation and to the morbidity following it Against th e fact that the closed pro-
cedure is "blind." annot create a tricuspid
valve, and the succ age of knives and dila
tors may cause u damage to the delicate
valve structure It e difficult to be certain
of an adequate r stenosis, and the inci-

Plate 234


Mammary gland
Ant. serratus m
Pectoralis major
B
A
Pectoralis minor
D
Ext. intercostal m.
4th rib
C
Pericardium
Phrenic n.
F
Lung
E

PULMONARY VALVOTOMY

A. The left side of the thorax is elevated slightly on a pillow and a transverse curvilinear inframammary incision is depicted.

B. The mammary gland is elevated, the line of incision through the pectoralis major and serratus anterior muscles is shown in dotted outline.

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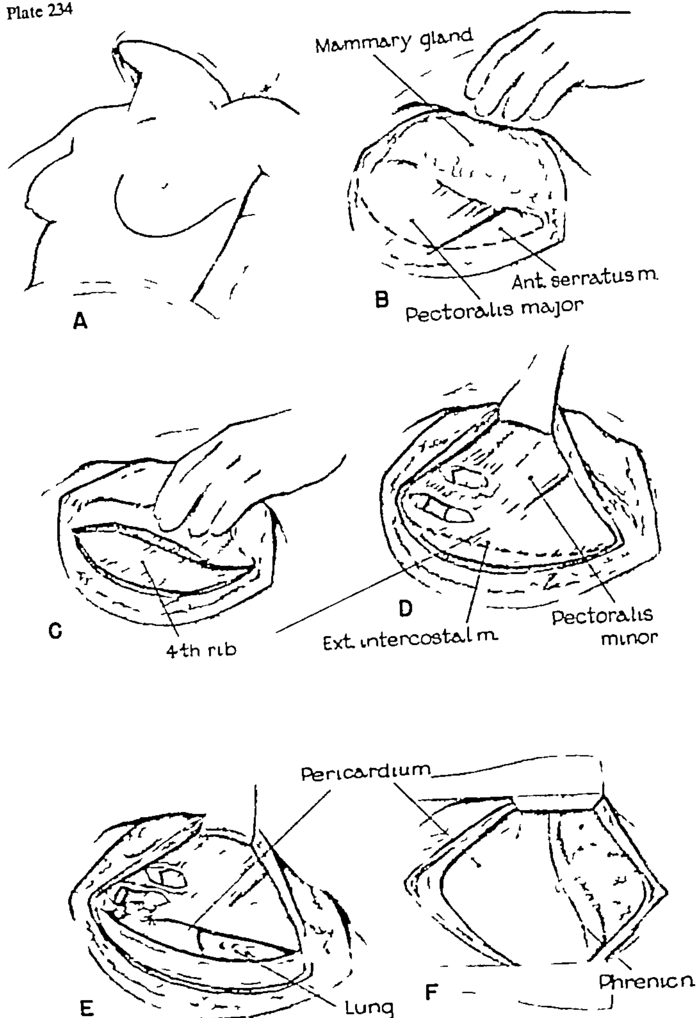
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DISCUSSION—DR. GEORGE H. HUMPHREYS, II. A congenitally stenosed pulmonary valve may be opened either by the closed method devised by Brock and depicted in Plates 234 through 236 or by the open method advocated especially by Swan and demonstrated in Plate 237. Although each method is well illustrated, it should be noted that, even with the transverse double thoracotomy incision (Plate 237A), exposure of the heart and great vessels is not as complete as the illustration implies. When the valve is exposed in the open procedure, remnants of commissures may be seen and the surgeon may elect to restore a tricuspid valve rather than to make a simple transverse incision as illustrated (Plate 237). If the valve is irregularly distorted, care must be taken to avoid creation of incompetence. The valve annulus is frequently stenotic and will require dilatation in the open as well as in the closed procedure.

Consideration of the relative advantages and disadvantages of each method is important. The closed method of Brock is the older and there is a tendency among many recently trained surgeons to consider it obsolete. However, it has the advantage of greater simplicity and, when properly done in the appropriate cases, its results are equally good. Although published series do not show a greater mortality in the open procedure there is no question that the need for bilateral thoracotomy and hypothermia or extracorporeal circulation add considerably to the risk of the operation and to the morbidity following it. Against this is the fact that the closed procedure is "blind." At best it cannot create a tricuspid valve, and the successive passage of knives and dilators may cause unnecessary damage to the delicate valve structure. It is also more difficult to be certain of an adequate relief of the stenosis, and the inci-

Plate 234


Mammary gland
Ant. serratus m.
Pectoralis major
A
B
4th rib
C
D
Ext. intercostal m.
Pectoralis minor
Pericardium
Lung
Phrenic n.
E
F

G The left lung, having been dissected from the pericardium, is covered by a moist gauze pad and retracted laterally The peri cardial sac is entered between traction guy sutures of silk (000) medial to the phrenic nerve, and the opening in the pericardium is extended by scissor dissection to form a flap, the boundaries of which are indicated in dotted outline.

H The formation of the pericardial flap is completed, and additional guy sutures of silk (000) have been inserted. Through the opening in the pericardium, portions of the anterior descending branch of the left cor onary artery and the adjacent surfaces of the right and left ventricles are visible

I The flap and cut margins of the pericar dium are retracted, and the anterior surface of the heart and its related structures are exposed. The anterior descending branch of the left coronary artery overlies the inter ventricular sulcus An incision is being made through a portion of the wall of the right ventricle between guy sutures of silk (00) in close proximity to the pulmonary conus

J Close up view to show a malleable probe with a ball point protected tip being in-serted by blunt force through the remain-ing portion of the incised wall of the right ventricle and through the stenotic orifice of the pulmonary valve into the lumen of the pulmonary artery The characteristic and diagnostic jetlike stream of blood flow ing through the stenotic orifice of the fused pulmonary valve and the tip of the probe as shown may be easily palpated by digital indentation of the anterior wall of the pul monary artery

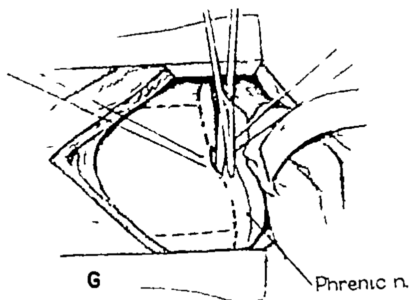
DISCUSSION—DR. HUMPHREYS (cont)

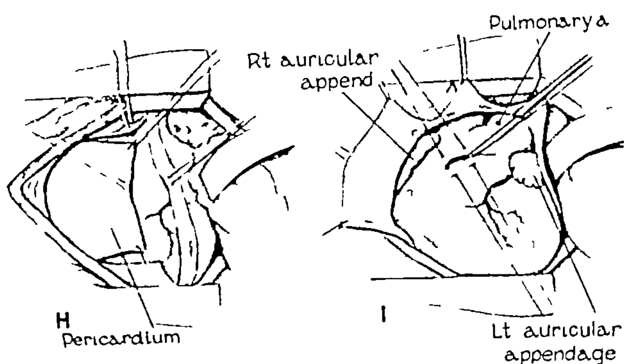
dence of persistent or recurrent stenosis is presum ably higher

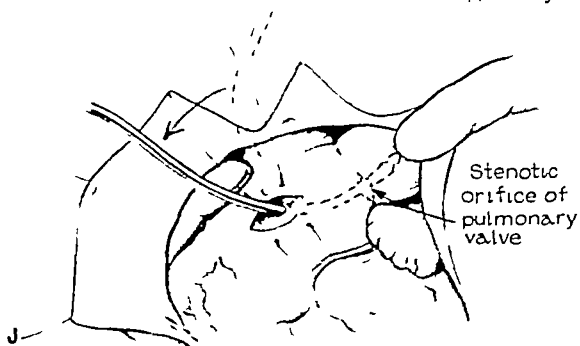
The open method has the advantage of direct vi-sion, with the possibility of more nearly complete restoration to normal by division in the commissures and tailoring of the cusps. It avoids a ventricular in cision and, in cases of poststenotic dilatation of the pulmonary artery permits some correction of this abnormality by the "reefing" effect of the pulmonary artery closure. Aside from the inherent risks of hypo-thermia, the use of inflow occlusion without extra corporeal circulatory support introduces a time lim-itation which puts an undesirable premium on speed. For this reason, as well as those discussed below there is an increasing tendency to use extracorpo-real support rather than hypothermia in spite of the more elaborate technical problems and presumably greater risks of the method.

The correction of associated anomalies, especially infundibular stenosis or septal defects, is impossible with the closed method or with the open method using hypothermia and inflow occlusion. These meth-ods are appropriate, therefore, only in cases of iso-lated valvular stenosis. Preoperative diagnostic tests to exclude other anomalies are essential, but, even then, an associated anomaly may be overlooked. Since secondary procedures to correct septal defects carry a higher risk than their correction at the first operation, it is highly desirable to correct all of the existing lesions at the first procedure If, therefore, there is any suspicion that the problem includes more than a simple isolated valvular stenosis, complete cardiac exploration with extracorporeal support is indicated.

Plate 235


G
Phrenic n.


Pulmonary a.
Rt auricular
append
H
Pericardium
I
Lt auricular
appendage


Stenotic
orifice of
pulmonary
valve
J

G The left lung, having been dissected from the pericardium, is covered by a moist gauze pad and retracted laterally The pericardial sac is entered between traction guy sutures of silk (000) medial to the phrenic nerve and the opening in the pericardium is extended by scissor dissection to form a flap, the boundaries of which are indicated in dotted outline

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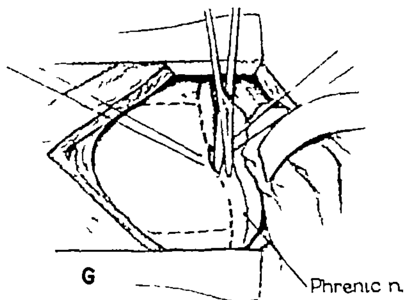
J Close up view to show a malleable probe with a ball point protected tip being inserted by blunt force through the remaining portion of the incised wall of the right ventricle and through the stenotic orifice of the pulmonary valve into the lumen of the pulmonary artery The characteristic and diagnostic jetlike stream of blood flowing through the stenotic orifice of the fused pulmonary valve and the tip of the probe as shown may be easily palpated by digital indentation of the anterior wall of the pulmonary artery

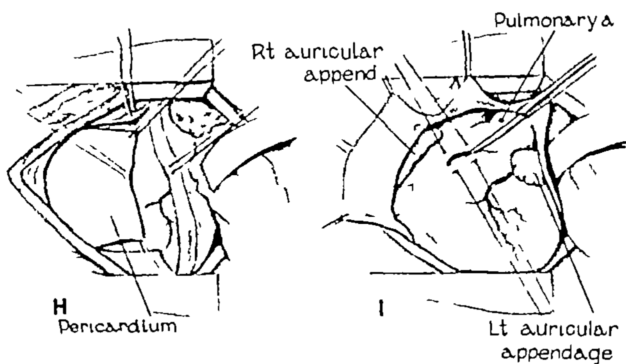
DISCUSSION—DR HUMPHREYS (cont.)

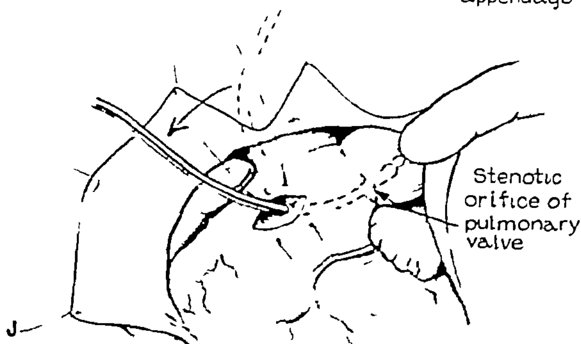
dence of persistent or recurrent stenosis is presumably higher

The open method has the advantage of direct vision, with the possibility of more nearly complete restoration to normal by division in the commissures and tailoring of the cusps. It avoids a ventricular incision and, in cases of poststenotic dilatation of the pulmonary artery permits some correction of this abnormality by the "reefing" effect of the pulmonary artery closure. Aside from the inherent risks of hypothermia, the use of inflow occlusion without extracorporeal circulatory support introduces a time limitation which puts an undesirable premium on speed. For this reason as well as those discussed below there is an increasing tendency to use extracorporeal support *rather than hypothermia in spite of the* more elaborate technical problems and presumably greater risks of the method.

The correction of associated anomalies, especially infundibular stenosis or septal defects, is impossible with the closed method or with the open method using hypothermia and inflow occlusion. These methods are appropriate, therefore, only in cases of isolated valvular stenosis. Preoperative diagnostic tests to exclude other anomalies are essential, but, even then, an associated anomaly may be overlooked. Since secondary procedures to correct septal defects carry a higher risk than their correction at the first operation, it is highly desirable to correct all of the existing lesions at the first procedure. If therefore, there is any suspicion that the problem includes more than a simple isolated valvular stenosis, complete *cardiac exploration with extracorporeal support* is indicated.


G
Phrenic n.


Pulmonary a.
Rt auricular append
H
Pericardium
I
Lt auricular appendage


Stenotic orifice of pulmonary valve
J

K. The probe is withdrawn, and a small knife of the Brock type is inserted through the fused valves into the lumen of the pulmonary artery Between the insertion and withdrawal of instruments bleeding from the ventricle is controlled by a combination of cross-traction on the guy sutures and digital pressure over the incision.

L. The cut in the valve is further enlarged by the insertion of first a medium and then a large Brock knife as depicted in dotted out line If preferred, a calibrated instrument as designed by Potts may be used.

M. A large urethral sound (29 F) is used to accomplish the final dilatation of the pulmonary valve orifice. This instrument is preferred to a clamp because it is associated with less blood loss.

N O For the control of hemorrhage after the removal of the sound, the guy sutures on either side of the incision in the myocardium are crossed, and finger compression over the incision is applied Closure of the incision is obtained with sutures of silk (00) inserted through the myocardium immediately beneath the finger

P Q The closure of the incision in the right ventricle is completed, and the pericardial flap is loosely approximated with interrupted sutures of silk (000). Small openings are present at either angle of the base of the flap to permit the escape of air and fluid collections into the pleural cavity

R. The fourth and fifth ribs are approximated with one pericostal suture of heavy silk (No 2) and a series of interrupted sutures of silk (000) in the intercostal muscle layer These sutures are all first inserted and individually tied. If preferred, heavy chromic catgut may be used for the pericostal suture The catheter (Foley No. 14 F), for water seal drainage of the pleural cavity has its exit through the intercostal incision.

S T U The completion of the layer closure of the wound using interrupted sutures of silk throughout.

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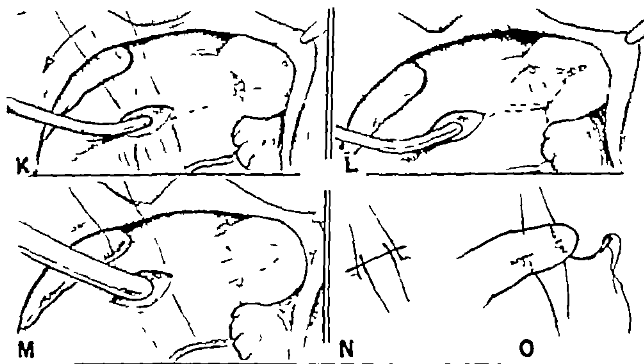
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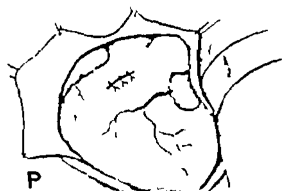
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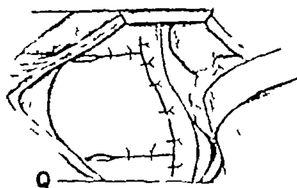
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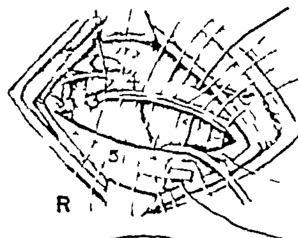
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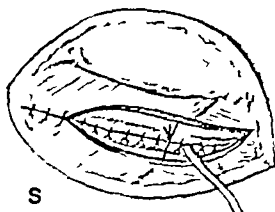
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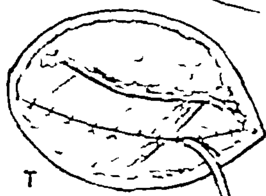

K
L
M
N
O


P


Q


R


S


T

The following illustrations depict an open or direct technic which may be employed in conjunction with either hypothermia as shown or with the use of a pump oxygenator and total bypass of the heart.

A. In the exposure of the heart, a Duval–Barasty longitudinal sternal splitting incision (dotted line) or a trans-sternal cross-bow incision (solid line) entering the fourth interspace on the right and the third interspace on the left, may be employed.

B. Cardinal guy sutures of silk (0000) are inserted in the anterior wall of the pulmonary artery about the site of the incision (dotted line) to be made. Preliminary to making this incision, the superior and inferior vena cava are occluded with cotton tape ligatures, and the base of the aorta and the pulmonary artery just proximal to its bifurcation are cross-clamped (Potts) To conserve time relative to the occlusion of the inflow tracts, it is preferable to first apply a clamp (Beck–Potts), in a longitudinal direction, to a segment of the pulmonary artery which is tented by the traction sutures previously inserted. An incision is then made between the guy sutures into the lumen of the occluded segment of the pulmonary artery Accordingly when the clamp is subsequently released, immediate entrance into the lumen of the pulmonary artery and exposure of the valvular stenosis is obtained (C) Swan has advocated the application of a noncrushing clamp across the aorta about 2 cm. *distal* to its origin and the injection of 0.5 ml. of 1 4000 Prostigmin into the aorta between the valve and the clamp shortly following (30 seconds) occlusion of the inflow tracts. A duration of 15 to 20 seconds for this injection is advocated. The aortic clamp is then removed, and occluding clamps are applied to the base of the aorta and the pulmonary artery (B C) The Prostigmin is used to prevent ventricular fibrillation in the hypothermic patient.

C. The incision in the pulmonary artery is retracted by the guy sutures, and the stenosis of the pulmonary valve is visible.

D E. The pulmonary valvotomy is being completed by scissor dissection (D). Immediately following, the operative field is flooded with sterile saline solution, and the incised margins of the anterior wall of the pulmonary artery are approximated by the guy sutures preliminary to the application of the Beck–Potts clamp (E). The occluding tape ligature on the superior vena cava, the clamps on the aorta and the pulmonary artery and finally the occluding tape ligature on the inferior vena cava are released in the order mentioned to restore the circulation in the heart and great vessels. The incision in the pulmonary artery is then sutured *(00000)*, first down *(E) and then back*, to be tied at its starting point.

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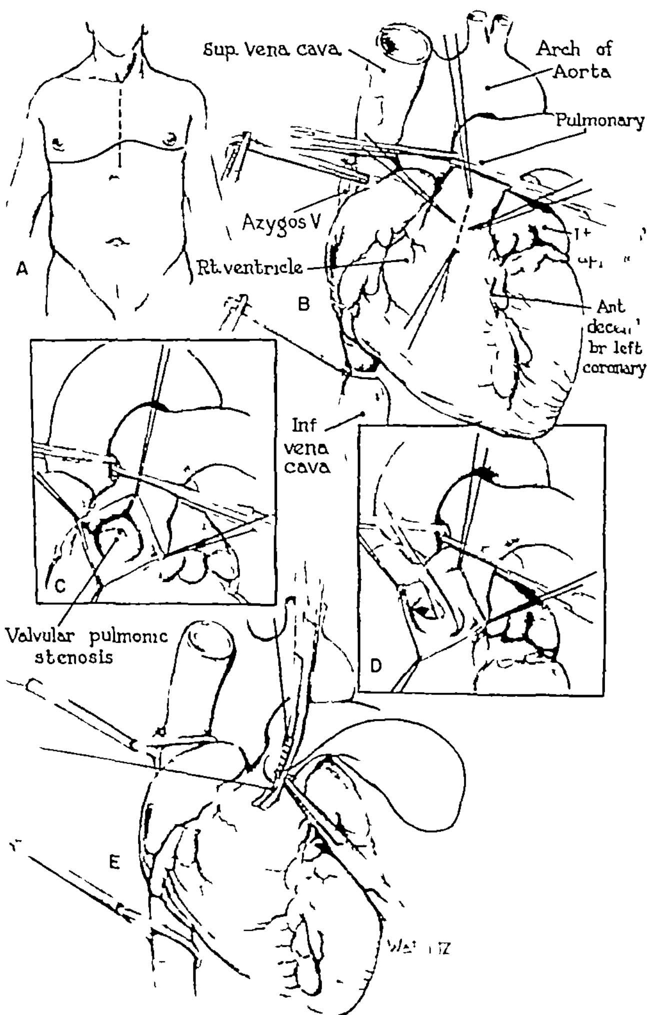
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A
Sup. Vena cava
Arch of Aorta
Pulmonary
Azygos V
Rt. ventricle
B
Ant
br left
coronary
Inf vena cava
C
D
Valvular pulmonic stenosis
E

A. The patient is placed in the direct right lateral prone position, and the thoracotomy incision immediately below the angle of the scapula is outlined.

B. The incision is deepened through the underlying musculature to expose the rib cage. A moist gauze sponge is inserted beneath the mobilized erector spinae group of muscles, and traction is maintained to demonstrate the angle of the fifth rib. The periosteum is removed from the lower half of the fifth rib anteriorly and the whole of the rib posteriorly after the manner of Brock. Posteriorly the endothoracic fascia and pleura are separated from the fourth and fifth ribs throughout the extent of the incision to obtain mobility of the adjacent rib cage. The fifth rib is retracted upward, and the incision in its bed is shown in dotted outline. In this technic the intercostal muscle bundle is not incised, and accordingly there is minimal bleeding.

C. The left pleural cavity is entered, and the fifth and sixth ribs are separated by a self retaining rib retractor. A portion of the pericardium either anterior or posterior (preferred) to the phrenic nerve is tented by traction sutures of silk (0000) and an incision is made into the pericardial cavity. The incision is extended upward, as indicated in dotted outline, and usually by scissor dissection to expose the anterior portion of the hilum of the lung and the dilated pulmonary artery.

D. Guy sutures of silk (000) are inserted through the cut margins of the pericardium, and, with traction on the sutures maintained, a portion of the left auricular appendage is visible within the pericardial cavity.

E. The tip of the left auricular appendage is mobilized with Babcock clamps, and a pursestring suture of silk (0) on a swedged on minimum trauma needle is inserted. In the insertion of this suture, the full thickness of the wall of the appendage is included.

F. The insertion of the pursestring suture posteriorly is completed, and its relation to the subjacent circumflex branch of the left coronary artery is visible. This vessel is not seen at operation because of the overlying fatty tissue. The auricular appendage receives one, and occasionally two arterial branches from the circumflex artery.

G. A Potts curved portacaval clamp is placed across the base of the auricular appendage immediately distal to the first pursestring suture and the site of incision in the terminal portion of the appendage is indicated. Resection of the tip of the appendage is no longer practiced.

H. After the incision into the lumen of the appendage is completed, the cut margins on either side are grasped in Babcock clamps and a second pursestring suture of silk (0) is inserted. In utilizing this open technic for the insertion of the second pursestring suture, one is assured that the opposite wall is not included in the suture. This technical error may occur in the closed technic, and the suture may be inadvertently cut when the incision is made into the lumen of the appendage.

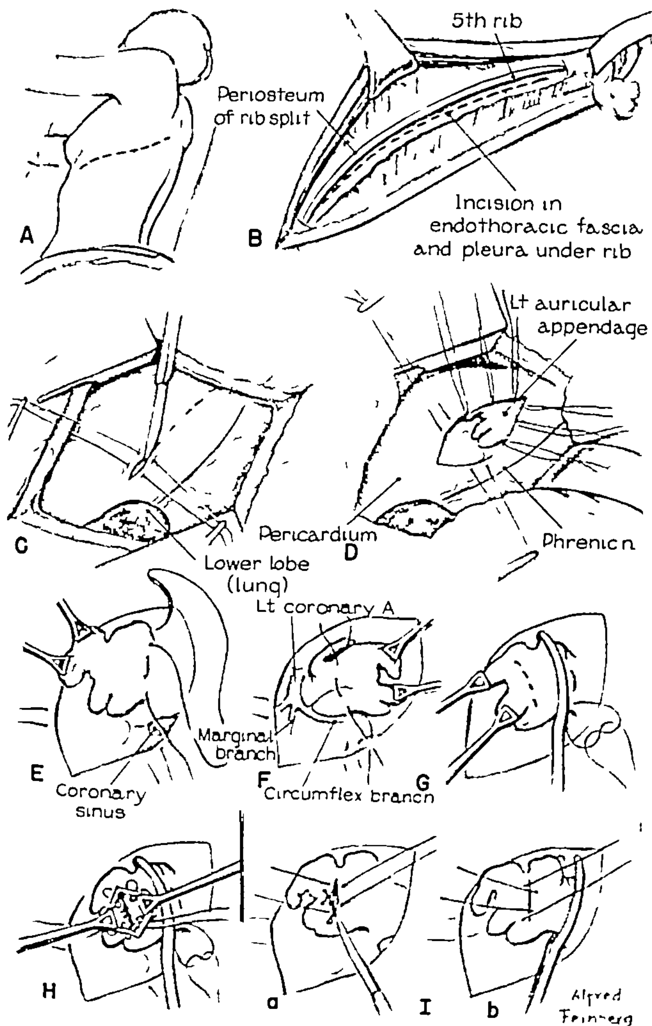
I. Inset to show an alternate technic that is preferred in patients in whom a history of recent thromboembolic episodes is obtained.

a. Guy sutures of silk are first inserted. A small incision is made between the sutures into the lumen of the appendage, and clots, if present, are allowed to extrude.

b. Active bleeding is controlled by crossing of the guy sutures and application of the curved Potts clamp proximally. The operation is then continued as previously described.

DISCUSSION—DR. ELLIOTT S. HURWITT. This is an admirable technic for opening the stenotic mitral valve. As performed at the Montefiore Hospital, the operation includes some variations that have proven to be extremely helpful. Many patients with advanced heart disease tolerate the lateral decubitus position poorly and, occasionally moderate elevation of the head and chest may be necessary to help prevent or control pulmonary edema. Consequently the position of the patient is about 30 degrees posterior to the true lateral, and the incision is placed more anteriorly than depicted (Plate 238A), extending from beneath the breast to below the angle of the scapula. Adequate exposure may be obtained by entering the pleural cavity through the fourth intercostal space.

The vertical pericardial incision is made considerably closer to the phrenic nerve than shown (Plate


5th rib
Periosteum of rib split
Incision in endothoracic fascia and pleura under rib
A
B
Lt auricular appendage
Pericardium
Phrenic n.
Lower lobe (lung)
C
D
Lt coronary A
Marginal branch
Coronary sinus
Circumflex branch
E
F
G
H
a
I
b
Alfred Feinberg

J The right index finger is inserted through the incision in the left auricular appendage and into the lumen of the left atrium as the clamp on the appendage is released and subsequently removed. If necessary for the control of hemorrhage, though usually not, the pursestring suture may be drawn taut.

K L. The tip of the index finger in dotted out line may be seen first engaging the stenotic orifice and then producing the "finger frac ture" or avulsion tear through the antero-lateral commissure. In some instances a preliminary subvalvular mobilization of the leaflets by avulsion of the chordae ten-dineae may be necessary before the com missurotomy may be performed. In other instances the use of a knife may be required. A unilateral, anterolateral commissurotomy may prove sufficient. However in general, a posteromedial commissurotomy should also be done. In the performance of a mitral commissurotomy it is important that the split in the commissure extends out to the annulus of the mitral ring in order to obtain the maximum benefit of the opera tion. For clarity the pursestring suture has been deleted.

L The orifice of the mitral valve in the presence of pure stenosis. The dash and dotted outlines indicate the direction of the an terolateral and posteromedial separation respectively of the fused valve leaflets.

L The orifice of the mitral valve in the presence of a combination of stenosis and regurgitation. The typical "key hole" defect involving the aortic leaflet (baffle) is depicted. Through this defect, the typical regurgitant jet is readily palpable. In the presence of a combined lesion of the mitral valve a unilateral, anterolateral commissurotomy only is preferred (dotted out line) because of the danger of increasing the regurgitant jet if an extension in a pos teromedial direction is performed.

M. The index finger is withdrawn from the lumen of the left atrium as the proximal pursestring suture, followed by the second pursestring suture, is tightened and tied by the first assistant. If desired, a Rumel tourniquet may be employed for tighten ing the first pursestring suture If one pursestring suture only is used, the clamp may be reapplied to the auricular appendage just above the purse string as the fin ger is being withdrawn. In such instances, the use of the clamp is an extra safety fac tor in the prevention of hemorrhage

N The approximation of the left auricular appendage following the tying of the two pursestring sutures and the closure of the incision in the auricular appendage with interrupted sutures of silk (00) are shown.

O. The incision in the pericardium is par tially closed with interrupted sutures of silk (000) The cut margins are loosely approx imated, and small openings are present at either end of the incision to permit the escape of collections of both air and fluid into the pleural cavity

Discussion—Dr. Hurwitt (cont.)

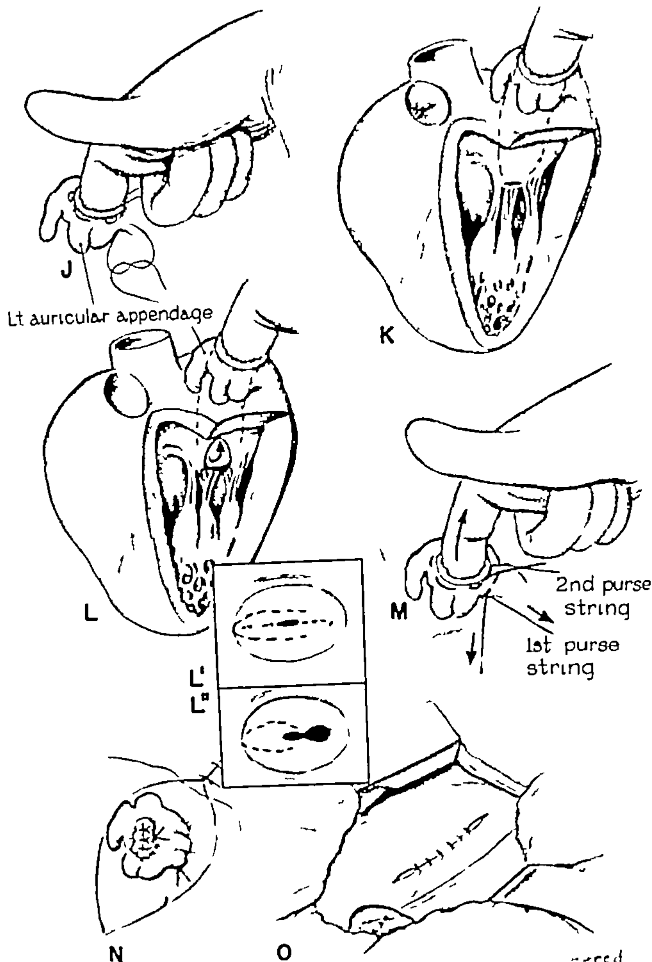
238C, D). Additional exposure may be obtained by mobilizing the phrenic nerve and making a short T-extension in the pericardial incision over the base of the auricular appendage. If the pursestring suture (Plate 238E, F) is begun and ended in the medial wall of the appendage, it may be controlled by the first assistant. Coordinated teamwork is of paramount importance in the subsequent maneuvers.

Of the wide variety of clamps available for application to the auricular appendage, the Satinsky clamp with the Glover grip has been highly satisfactory Traction sutures in the lips of the auricular incision have been of considerable help in facilitating the exposure and in controlling the auricle. As the operator disengages the auricular clamp with his left hand and insinuates his right index finger into the heart, the pursestring and traction sutures are manipulated by the assistants The effectiveness of the intracardiac finger may be augmented by pushing against the operator's left hand, placed over the upper portion of the anteromedial wall of the left ventricle Pericardial drainage into the pleural space is promoted by a looser pericardial closure than illustrated (Plate 239O). Underwater drainage of the pleural cavity is accomplished by an intercostal tube.

Although time may not be of major importance in the performance of many operations, survival of the desperately ill patient with tight mitral stenosis and severe pulmonary hypertension may occasionally depend on the shortest possible lapse of time between induction of anesthesia and opening of the valve. Under such circumstances, it is wise to defer the ligation or electrocoagulation of the blood vessels in the thoracic wall until one is ready to close the chest.

REFERENCES (see page 640)

Plate 239


J
Lt auricular appendage
K
L
L'
L''
M
2nd purse string
1st purse string
N
O

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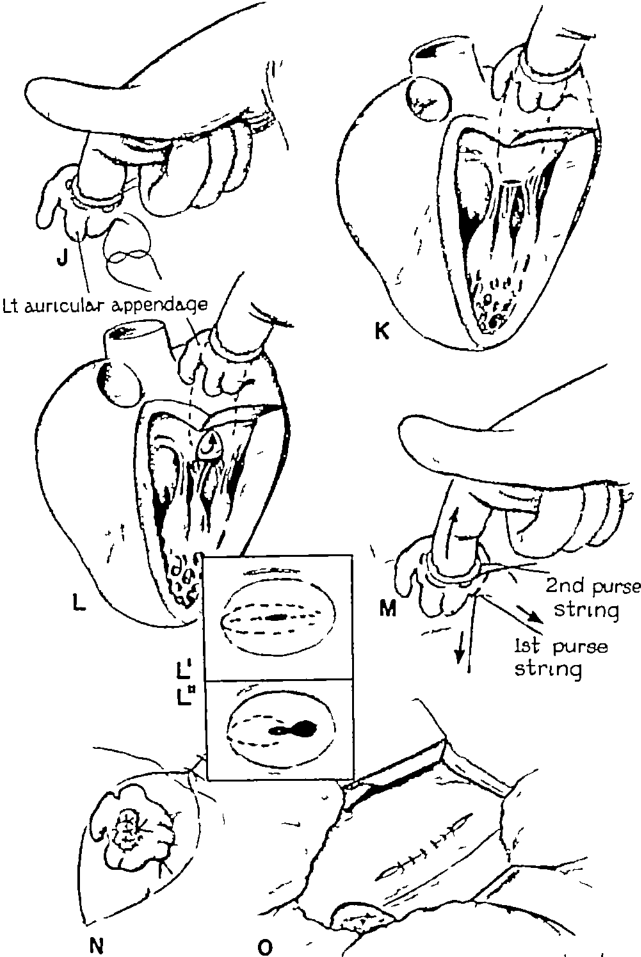
DISCUSSION—DR. HURWITT (cont.)

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DISCUSSION—DR. HURWITT (cont.)

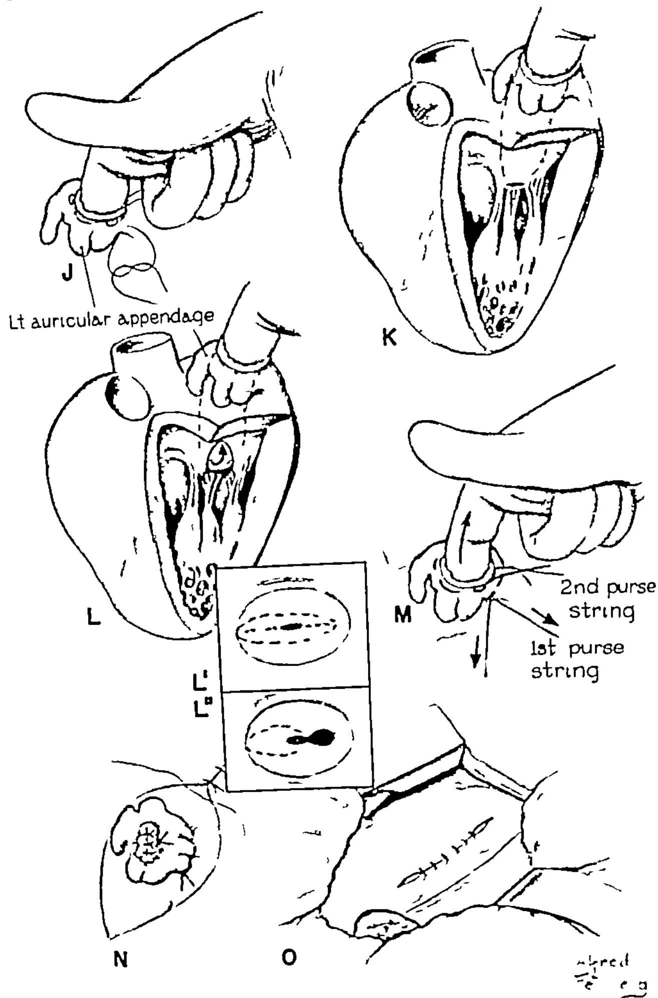
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2nd purse string
1st purse string
N
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CARDIOPERICARDIOPEXY

A. The relatively short (8 to 10 cm.) infra mammary incision directly overlying the left fifth interspace is depicted by the solid line.

B. The skin incision is deepened through the underlying subcutaneous fatty tissue layer and the fibers of the pectoralis major muscle to expose the costal cartilage of the fifth rib

C D E. The perichondrium of the fifth costal cartilage is incised (C), and perichondrial flaps are elevated (D E) A long segment or the whole of the costal cartilage is then re moved (E).

F G G¹ The bed or posterior perichondrium of the partially resected fifth costal cartilage is incised (F), and, after extension of the in cision, the cut margins are secured by trac tion sutures of 0000 silk (G) Beneath the incision, portions of the pericardial fat and parietal pleura are visible. On occa sions an opening may be accidentally made through the parietal pleura into the left pleural cavity If this should occur the opening is temporarily occluded with a moist gauze pad and the operation continued. At the completion of the poudrage any pneumothorax present is removed by complete expansion of the lung while the chest wall incision is being closed. The inset (G) shows the internal mammary artery doubly clamped and being severed with a scalpel. This is done routinely as a technical expediency in the performance of a cardiopericardiopexy If desired, the right internal mammary artery may be similarly clamped, severed, and ligated following the completion of the cardiopericardiopexy

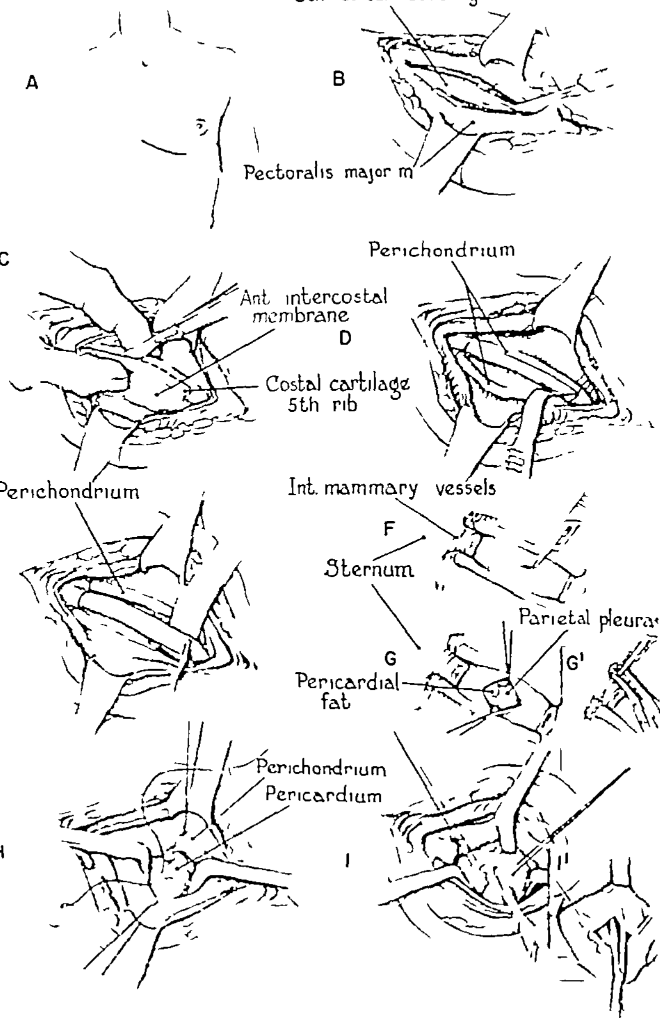
H, I, I¹ Guy sutures of silk (00) are inserted in the parietal pericardium (H, I), and, with traction maintained through the sutures, an incision is made into the pericardial cavity (I) and subsequently extended by scissor dissection (I¹).

DISCUSSION—DR. SAMUEL A. THOMPSON Cardiopericardiopexy is a method of myocardial revascularization, and, as such, it is essentially a form of myocardial surface irritation. It stimulates the forma tion of extracardiac as well as intercoronary collateral circulation. It is a simple operation and attended with a low surgical mortality The results over a period of 19 years have not been surpassed by any other method.

The operation is entirely extrapleural, and the approach is over the left fifth costal cartilage (Plate 240A). This cartilage is stripped of its perichondrium and then removed completely from the sternal junction to the costochondral junction (Plate 240B, C D E) Opening the posterior perichondrium along the entire cartilage bed (Plate 240F G) exposes the thin fibers of the transverse sterni muscle. The fibers are gently elevated and severed this exposes the pericardium and parietal pleura The parietal pleura is gently retracted laterally Occasionally in so doing, a small tear may occur in the pleura. No attempt should be made to repair this, but it should be temporarily covered with a moist gauze pad and the operation continued. Any pneumothorax which may be present is eliminated by complete expansion of the lung during closure of the chest wall structures. Ligation of the internal mammary artery (Plate 240G), which is done as a routine procedure in cardiopericardiopexy appears to increase the vascularity of the pericardium. If the right internal mammary artery is to be ligated, it can be done through a separate small incision in the right second intercostal space at the conclusion of the cardiopericardiopexy

The pericardium is elevated by two guy sutures (Plate 240H I), and a small incision is made. If there is an abnormal amount of pericardial fluid present or if the fluid is under increased pressure, each myocardial beat will force a small jet of fluid from the in cision. The pericardial incision is enlarged in a direc tion parallel to the skin incision or in a transverse direction (Plate 240 I), and thorough aspiration of all possible pericardial fluid is attempted by means of a soft rubber catheter Frequent extra systoles may occur during this maneuver but are of no serious consequence. Thorough removal of the pericardial fluid is important since any quantity of residual fluid may wash the powdered talc to the dependent recesses of the pericardium, and the resulting myocardial sur face irritation may be limited to the apical area instead of being generalized as is desired.

Magnesium silicate (U.S.P talc) is the irritating material used to cover the epicardial surface of the heart. This is widely distributed over the anterior sur face and borders of the heart by means of a special powder distributor (Plate 241J). Depending upon the size of the heart, from 2 to 6 gm. of talc are used.


A
B
5th costal cartilage
Pectoralis major m
C
Ant intercostal membrane
D
Costal cartilage 5th rib
Perichondrium
Perichondrium
E
Int. mammary vessels
F
Sternum
Parietal pleura
G
G'
Pericardial fat
Perichondrium
Pericardium
H
I

J Three guy sutures of silk (000) are inserted at equidistant points in the incised margins of the parietal pericardium, and the adjacent surroundings are walled off with moist gauze pads. Upward traction is maintained on the three guy sutures as the dry powdered talc is inserted into the pericardial sac and onto the epicardial surface of the heart covering the anterior surface and lateral margins. The various planes in which the talc is deposited are indicated by the varying positions of the Thompson powder distributor (dotted out lines). The moist gauze pads about the oper*ative field serve to prevent the deposit of talc* onto the adjacent tissues.

K. Upon completion of the insertion of the talc (2 to 6 gm.), the moist gauze pads are removed, and the interrupted silk (000) sutures used to close the incision in the anterior parietal pericardium are inserted but not tied.

L. The closure of the pericardial incision is completed, and the insertion of the silk (000) sutures in the incised bed of the fifth costal cartilage is begun. Portions of the pericardial fat and parietal pleura are also visible.

M N. The closure of the incision in the costal bed is completed, and the beginning of the insertion of interrupted silk (000) sutures to approximate the cut margins of the pectoralis major muscle and the underlying flaps of anterior perichondrium as a unit layer is shown (M) The completed closure is de picted in N

O The closure of the skin incision with inter rupted sutures of silk (000) completes the operation. No drains are used.

Discussion—Dr. Thompson (cont.)

and no attempt is made to cover the posterior sur face, as the beating of the heart will carry a sufficient amount to this area

Upon completion of the powder distribution, quite frequently there is a decided drop in the patient's blood pressure The anesthetist should expect this, and, if it occurs, counteract it by the use of an in travenous pressor drug.

The pericardium is loosely closed with interrupted sutures, and the soft structures of the chest wall are closed in anatomic layers without drainage.

In a period of almost twenty years, there has been no evidence that cardiopericardiopexy produces any degree of constrictive pericarditis or becomes avascular

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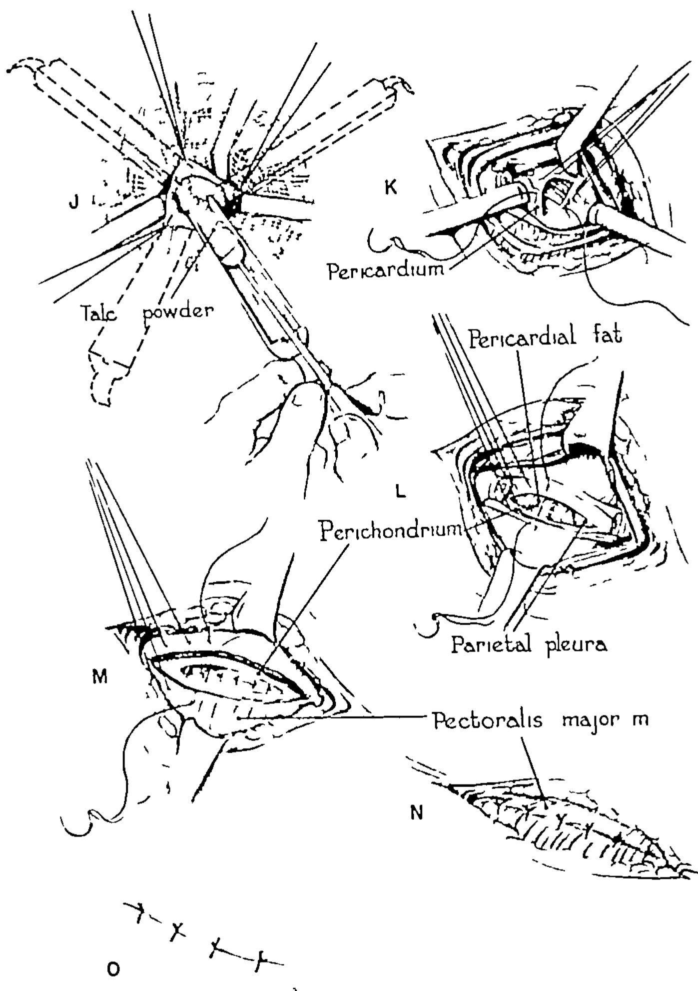
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Plate 241


J
Talc powder
K
Pericardium
Pericardial fat
L
Perichondrium
Parietal pleura
M
Pectoralis major m
N
O

CARDIAC RESUSCITATION

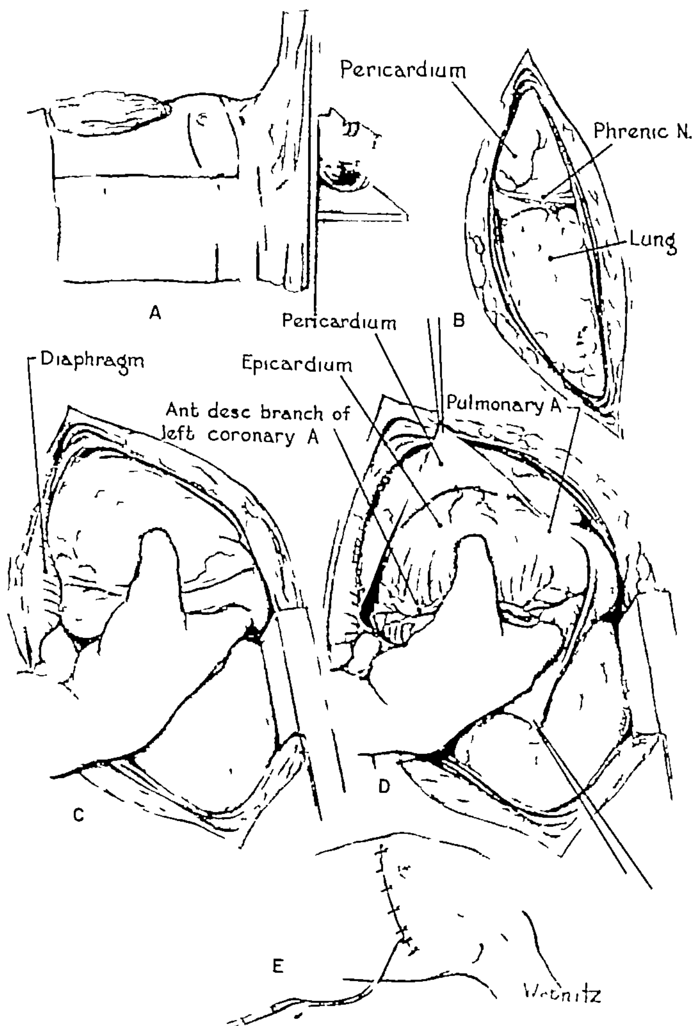
A. In this patient, acute cardiac arrest occurred during the course of an abdominal exploration. The abdominal wound was covered by a moist pad and towel. The left anterolateral thoracotomy incision overlying the fifth interspace is depicted by the dotted line

B. The left pleural cavity is entered with a bold sweep of the scalpel, and the underlying intrapleural structures are demonstrable

C, D Immediate manual massage of the heart is performed and continued as a self retaining rib retractor (Tuffier) is inserted. Concomitant with massage, artificial respiration is maintained, preferably through an intratracheal tube, either by rhythmic compression of the rebreathing bag using 93 per cent oxygen and 7 per cent carbon dioxide or by the use of a mechanical ventilator such as the Jefferson type. The placement of the patient in a 30-degree Trendelenberg position is a gravity aid in restoration of the circulation to the brain. Initially the pericardium is not opened (C) because this would entail an unnecessary waste of time in the establishment of an artificial circulation to supply the immediate tissue needs of the body However if desirable subsequently the pericardium may be incised and intrapericardial massage continued (D) In the performance of manual massage, the heart is cupped in the hand with the apex directed toward the base of the palm. The fingers are inserted posterior and the thumb anterior to the heart, and rhythmic compression is performed. The rate of compression is 50 to 60 times per minute Intermittently the epicardial surface of the heart is irrigated with warm saline solution as an aid to conduction. When a spontaneous rhythm is restored, manual massage is discontinued momentarily and the cardiac activity is observed. Frequently the heart rate will slow perceptibly and even come to a standstill unless manual massage is again performed. Under such circumstances, calcium chloride (5 ml of 5 per cent solution) or epinephrine (1 ml. of 1 1000 solution) may be used. Following the use of such drugs, the restoration and maintenance of a forceful cardiac rhythm frequently occurs. In the event of ventricular fibrillation, cocaine (10 per cent) may be used topically in conjunction with the continuation of manual massage, or an electrical defibrillator may be employed.

E. A layer closure of the thoracotomy incision is performed about a Foley catheter (No. 16 F) which is used for water-seal drainage of the pleural cavity If desired, the catheter may have its exit through a separate stab-wound drainage site below the incision.

REFERENCES (see page 641)


Pericardium
Phrenic N.
Lung
A
B
Pericardium
Diaphragm
Epicardium
Ant desc branch of
left coronary A
Pulmonary A
C
D
E
Wernitz

AORTIC EMBOLECTOMY

A. A left paramedian incision as depicted is preferred. The incision extends approximately one third above and two thirds below the level of the umbilicus

B. The peritoneal cavity is entered, the intestines are displaced upward, and the posterior parietal peritoneum is incised to expose the lower portion of the abdominal aorta and its bifurcation The lumen of the aorta is occluded by digital compression,* and the anterior wall of the aorta overlying the contained thrombus is incised. The thrombus which extends distally into both common iliac arteries is herniated partially through the incision. This herniation of the thrombus causes an eversion of the incised margins of the intima and facilitates the subsequent insertion of the everting mattress sutures of fine (00000) silk. The spasm of the left iliac artery distal to the thrombus is visible

* If for technical reasons the use of the index finger proves unsatisfactory a 10-inch length anatomic tissue forceps may be conveniently substituted.

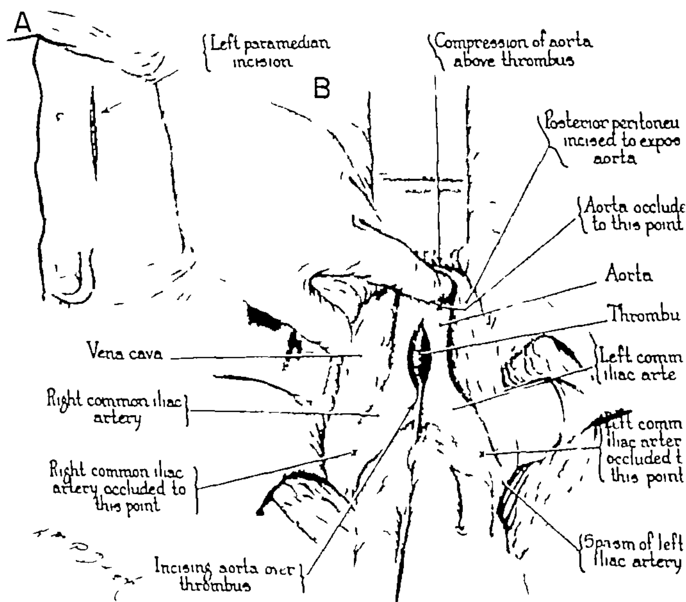
The surgical approach to the lower portion of the aorta and its bifurcation may be extraperitoneal, transperitoneal, or retrograde The transperitoneal approach, spinal anesthesia being used, is preferred. Although objected to by many the advantages are believed to exceed the proclaimed disadvantages.

The basic principles that are believed to underlie the successful surgical removal of an arterial embolus are (1) an early operation, preferably within the first eight hours (2) an adequate surgical exposure (3) the production of
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Thrombi which are formed where found


A
B
Left paramedian incision
Compression of aorta above thrombus
Posterior peritoneu incised to expos aorta
Aorta occlude to this point
Aorta
Thrombu
Vena cava
Left comm iliac arte
Right common iliac artery
Left comm iliac arter occluded t this point
Right common iliac artery occluded to this point
Spasm of left iliac artery
Incising aorta over thrombus

A. A left paramedian incision as depicted is preferred. The incision extends approximately one third above and two thirds below the level of the umbilicus.

B. The peritoneal cavity is entered, the intestines are displaced upward and the posterior parietal peritoneum is incised to expose the lower portion of the abdominal aorta and its bifurcation. The lumen of the aorta is occluded by digital compression,* and the anterior wall of the aorta overlying the contained thrombus is incised. The thrombus which extends distally into both common iliac arteries is herniated partially through the incision. This herniation of the thrombus causes an eversion of the incised margins of the intima and facilitates the subsequent insertion of the everting mattress sutures of fine (00000) silk. The spasm of the left iliac artery distal to the thrombus is visible

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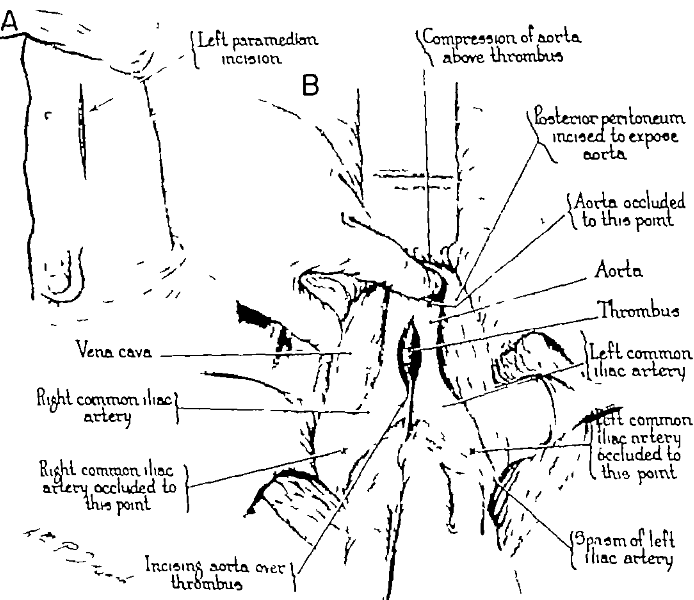
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The basic principles that are believed to underlie the successful surgical removal of an arterial embolus are (1) an early operation, preferably within the first eight hours, (2) an adequate surgical exposure (3) the production of a minimum of trauma, particularly in the intima, (4) the interruption of the circulation for a minimum period after the thrombus is removed.

In most of the surgical technics commonly employed for aortic embolectomy mechanical devices or tape ligatures are used to occlude the aorta proximal to the blockage and the common iliac arteries distally In the majority of patients with a saddle occlusion of the abdominal aorta, varying degrees of atherosclerosis are present. This is the reason why it is believed that most of the so-called saddle emboli in patients in the arteriosclerotic age group are in reality autochthonous thrombi* The degenerative changes occur predominantly in the posterior and lateral walls of the aorta. The occlusion of the lumen of the aorta by a mechanical device, a traction tape ligature, or an occluding tape ligature may produce a fracture of an atherosclerotic plaque with resultant injury to the intima. This predisposes to the formation of a local thrombus. In general, the use of such methods for hemostasis requires the complete mobilization of the distal portion of the abdominal aorta and its bifurcation. A notable exception is the technic described by Linton. This mobilization of the aorta prolongs the operation, risks the danger of dislodging a portion of the thrombus to form an embolus, and increases the likelihood of troublesome hemorrhage.

In the technic illustrated, mechanical devices or tape ligatures for hemostasis are not used. Instead, for this purpose, the left index finger of the assistant or an anatomic tissue forceps 10 inches in length is employed. Protective rubber shods predispose to slipping of the forceps off the walls of the aorta and are not used. The use of the index finger or tissue forceps produces a minimum of tissue trauma, does not require the mobilization of the aorta, and permits the immediate release or application of a compression force to the aorta, a desired technical aid. Furthermore, a delicate adjustment of the compression force applied may be obtained. The same principles of technic illustrated are employed for the removal of the more peripherally located arterial emboli.

* Thrombi which are formed where found


A
Left paramedian incision
B
Compression of aorta above thrombus
Posterior peritoneum incised to expose aorta
Aorta occluded to this point
Aorta
Thrombus
Left common iliac artery
Left common iliac artery occluded to this point
Spasm of left iliac artery
Vena cava
Right common iliac artery
Right common iliac artery occluded to this point
Incising aorta over thrombus

AORTIC EMBOLECTOMY

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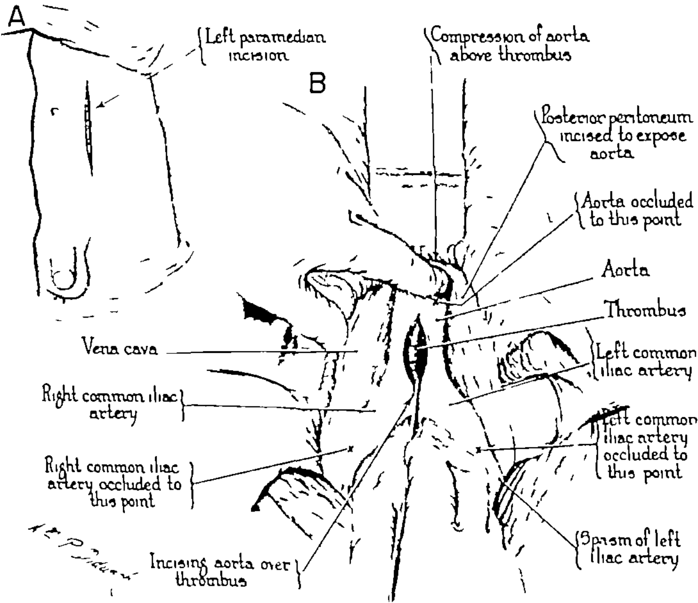
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Thrombi which are formed where found


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Posterior peritoneum incised to expose aorta
Aorta occluded to this point
Aorta
Thrombus
Vena cava
Left common iliac artery
Right common iliac artery
Left common iliac artery occluded to this point
Right common iliac artery occluded to this point
Spasm of left iliac artery
Incising aorta over thrombus

C. Digital compression of the aorta is maintained proximal to the thrombus, and the untied strands of silk sutures are retracted on a nerve hook to allow the free escape of the blood clots The thrombus, first in one then in the other common iliac artery is "milked" upward and extruded through the opening in the aorta. The demonstration of free retrograde bleeding following this maneuver indicates the patency of the collateral vascular channels below the site of the aortic occlusion, which is a favorable prognostic sign.

D The common iliac arteries are occluded by digital compression immediately distal to the bifurcation of the aorta, either by the right hand of the first assistant or the left hand of the surgeon, as the digital compression of the lumen of the aorta proximal to the thrombus is slowly released. Generally the pressure in the aorta is sufficient to expel forcibly through the aortic incision the remaining portion of the thrombus. If not, the thrombus may be evacuated by "milking" it downward from above by gentle digital compression The discharge of the thrombus is followed by a forceful pulsatile flow of blood, the control of which is being initiated by traction on the untied strands of the silk mattress sutures The digital occlusion of the common iliac arteries is done to prevent the dissemination of thromboemboli into the peripheral arterial bed.

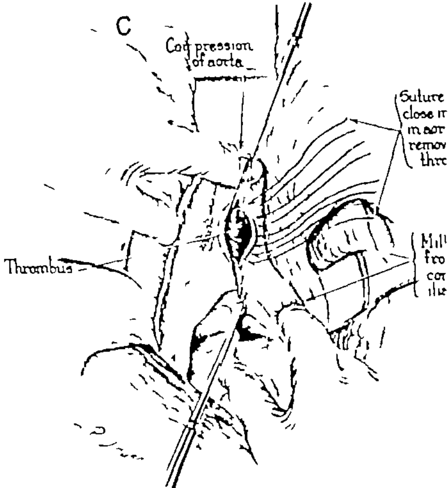
DISCUSSION—DR. FERDINAND F MCALLISTER. I am in general accord with the principles outlined in this section, but have employed minor variations in technic Lower abdominal midline incisions have been found very helpful in exposure of the aorta and both iliacs. The midline position allows equally good exposure for either iliac, can be rapidly extended upward if need be, and is more quickly closed. I have *not observed any greater tendency to postoperative* hernia through this incision than through a paramedian muscle-retracting incision.

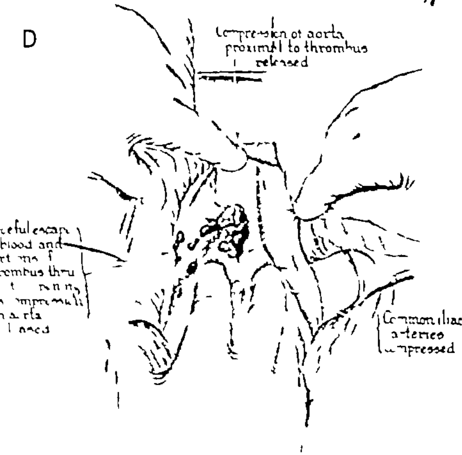
I have felt that it is important to carefully encircle the iliac vessels with doubly looped umbilical tapes, distal to the area of obvious involvement with embolus before any manipulation of the involved area is attempted. With the use of these tapes it may be possible to prevent any fragmentation and passage of clot more distally Whenever such occlusion is performed with the tapes, 2 to 3 ml. of heparin solution should be injected into the vessels distal to the area of occlusion. As far as proximal occlusion of the aorta goes, above the level of the embolus I have felt more secure with complete encirclement of the aorta with a tape and the employment of a Rumel type tourniquet In some emboli which have been tackled after two to three days the clot is rather adherent and a good deal of manipulation may be required to loosen it. I have not felt that finger control is adequate for this, and I do not believe that the careful use of thick cotton tapes fragments the intima excessively Again, whenever the aorta has been occluded proximally 2 to 3 ml. of heparin solution should be injected proximal to the area of occlusion

I have always felt that the best vascular closure was a simple over and over stitch of accurately placed 00000 arterial silk. I do not believe that the time factor here is as important as stressed by the author since the aorta has been occluded for some time anyway by the embolus. The entire lumen previously occupied by the embolus should be carefully and frequently and thoroughly flushed with heparin *solution until the closure is complete.* Once the closure is complete, the hemostatic tapes should be immediately released, and, unless drastic hemorrhage ensues through the wound, the vessel should never again be completely occluded, for this is sure to lead to clot formation. Care should be taken to control the proximal aorta digitally as the proximal tape is released in order to precipitate neither shock nor the reflexes which have been shown to lead ultimately to lower nephron nephrosis with renal shut down

Since additional distal emboli due to fragmentation of clot are not uncommon in such patients, two precautions should be taken before embarking on the performance of saddle embolectomies. First, the groins and thighs should be included in the prep and drape, so that if necessary the femoral arteries can be quickly exposed for the extraction of additional clots Second, a selection of plastic and firmly polished catheters should be available to insert into the distal iliac vessels if back bleeding is poor following removal of the main thrombus. Frequently a long complete slender thrombus can be extracted by the judicious use of such catheters and obviates the need for additional embolectomies at lower levels.

Plate 244


C
Compression of aorta
Thrombus


D
Compression of aorta proximal to thrombus released
Common iliac arteries compressed

E. The thrombus is completely evacuated, and the lumen of the aorta is momentarily occluded proximal to the incision either by the index finger (first assistant), as depicted, or by an anatomic tissue forceps (10 inches) as the strands of silk mattress sutures are drawn taut to close the opening in the aorta. The operative field is toileted by irrigation with warm sterile normal saline solution which is removed by suction siphonage.

F The compression of the aorta and the common iliac arteries is released, and the last of the everting mattress sutures of silk (00000) closing the aortic incision is being tied. If sites of bleeding in the incised aorta should persist, hemostasis is obtained either by gentle compression on the suture line for several minutes using a sterile dry gauze sponge or by the insertion of additional simple interrupted silk (00000) sutures, dependent upon the severity of the bleeding. The incised portion of the posterior parietal peritoneum is not sutured. A layer closure of the abdominal incision is performed using interrupted sutures of 00 silk for the peritoneum and fascia and 000 silk for the skin. Drainage of the wound is not employed. Because of the high incidence of complications due to hemorrhage anticoagulant therapy postoperatively has been discontinued.

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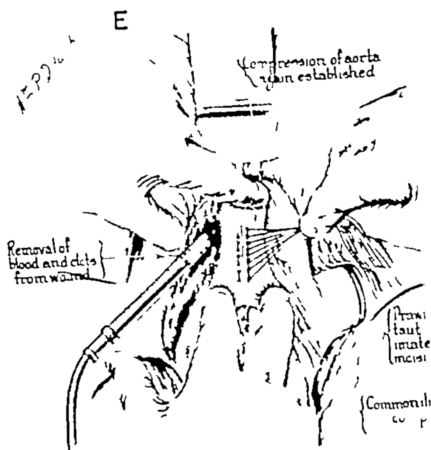
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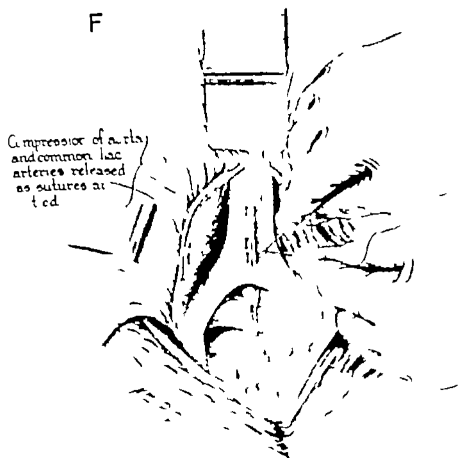
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Plate 245


E
compression of aorta again established
Removal of blood and clots from wound
Commonil


F

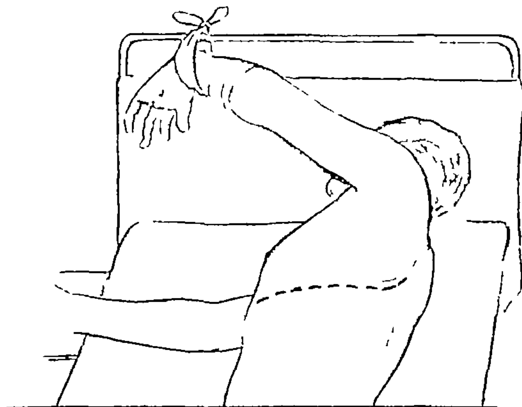
EXCISION OF AN ANEURYSM OF THE THORACIC AORTA AND THE INSERTION OF A PRESERVED HOMOLOGOUS AORTIC GRAFT

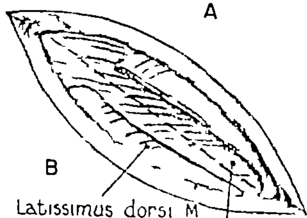
A. The patient is placed in the direct right lateral prone position. The site of the left thoracotomy incision is depicted by the dotted line.

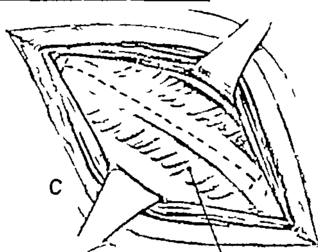
B C. The skin incision is deepened through the underlying musculature of the lateral thoracic wall (B C). The H-shaped incision to be made in the periosteum of the sixth rib (C) is shown in dotted outline

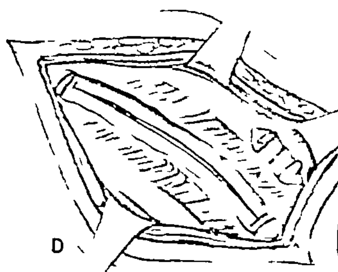
D A long segment of the sixth rib and a small segment of the posterior portion of the fifth rib are resected subperiosteally The severance of the intervening intercostal muscle layers and their neurovascular bundle is indicated by the dotted line.

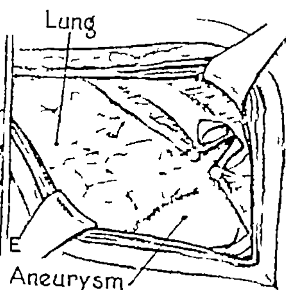
E. The intercostal muscle layers and the related neurovascular bundle are severed and ligated with suture ligatures of silk (00). The wound margins are retracted, and a portion of the aneurysm which is partly covered by the overlying and adherent left lung is visible within the pleural cavity


A


B
Latissimus dorsi M
Serratus anterior (magnus) M


C
Ext intercostal M


D


Lung
E
Aneurysm

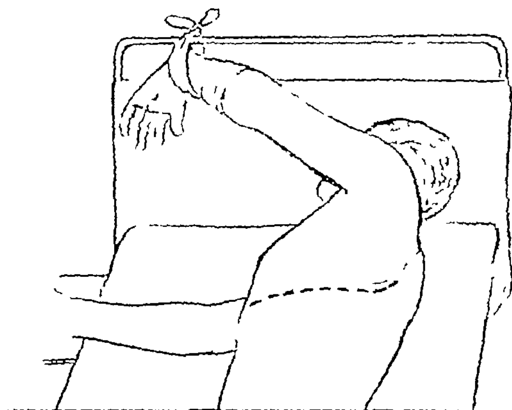
EXCISION OF AN ANEURYSM OF THE THORACIC AORTA AND THE INSERTION OF A PRESERVED HOMOLOGOUS AORTIC GRAFT

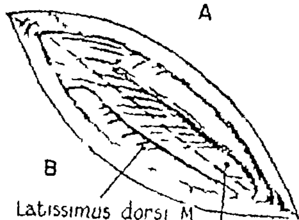
A. The patient is placed in the direct right lateral prone position. The site of the left thoracotomy incision is depicted by the dotted line

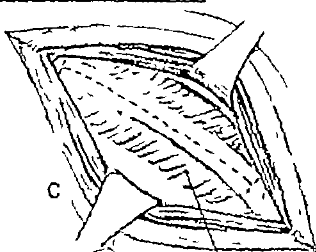
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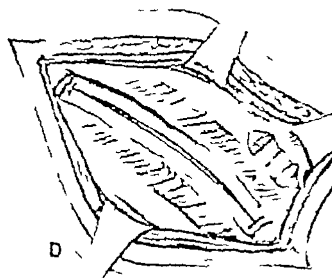
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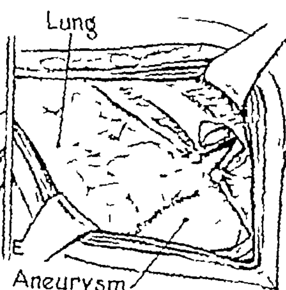
E. The intercostal muscle layers and the related neurovascular bundle are severed and ligated with suture ligatures of silk (00). The wound margins are retracted, and a portion of the aneurysm which is partly covered by the overlying and adherent left lung is visible within the pleural cavity


A


B
Latissimus dorsi M
Serratus anterior (magnus) M


C
Ext intercostal M


D


Lung
E
Aneurysm

F The rib cage is widely separated with a self retaining rib retractor (Finochietto) to expose more completely the underlying intrapleural structures. The adherence of the atelectatic lower lobe of the left lung to the wall of the aneurysm is visible. In this particular illustration, the cephalad extent of the aneurysm located in the middle segment of the descending aorta is somewhat higher than the actual level observed at the time of operation. This level is accurately shown in the subsequent illustrations

G The superior segment of the left lower lobe partially dissected from the wall of the aneurysm, is clamped (Babcock) and retracted. The posterior parietal pleura, overlying the proximal portion of the descending aorta and the distal segment of the arch, is incised. The cut margins of the parietal pleura are retracted with guy sutures of silk (000), and the uppermost of the paired intercostal arteries are shown mobilized on a clamp and ligature carrier respectively

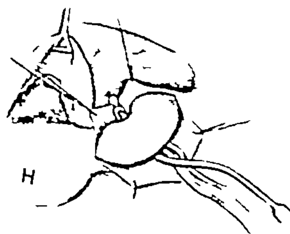
H I Following the ligation and severance of the two intercostal vessels, a special ligature carrier with a ball-point protected tip (H) is used to encircle the mobilized segment of the thoracic aorta proximally with a cotton tape (I).

Manufactured by Edward Weck & Co., Brooklyn, N Y

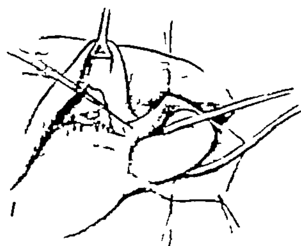
Pericardium
Phrenic N
Atelectatic lower lobe left lung
Upper lobe
Aneurysm thoracic aorta
Arch of aorta

F

G



H

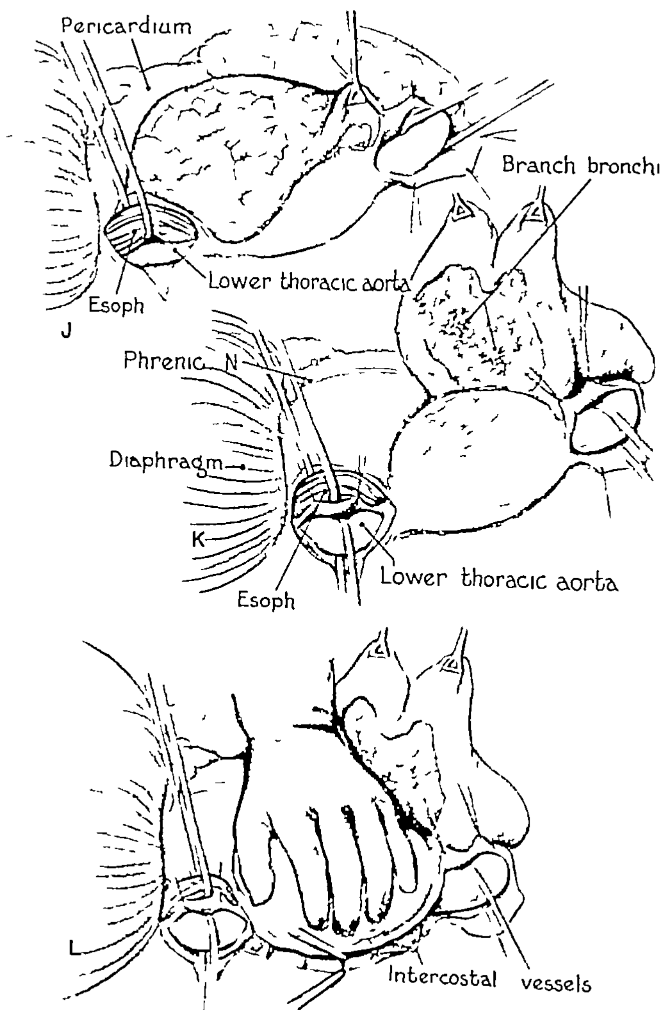


I

J An incision is made in the posterior mediastinal and parietal pleura distal to the aneurysm, and the lower end of the esophagus is shown encircled by a cotton tape. A segment of the distal portion of the thoracic aorta is also visible.

K. The distal segment of the thoracic aorta is similarly encircled by a cotton tape and the adherent lobe of the left lung is dissected completely from the surface of the aneurysm. The lines of closure of the openings in the small stem bronchi, made during the dissection, are visible. In retrospect, this was a technical error which could have been easily avoided by not performing the dissection as illustrated. Instead, at the time of the resection of the aneurysm, a portion of its wall that was intimately adherent to the lung could have been tailored to form a "patch" graft and the occurrence of bronchial air leaks obviated. The same reasoning applies to the separation of the wall of the aneurysm from the segment of the esophagus to which it was adherent. The use of a "patch" graft is ideally suited as a prophylaxis to injury of the esophagus.

L. Preparatory to mobilizing the aneurysm, the incision in the posterior parietal pleura is extended along the whole length of the posterior border of the aneurysm. By gentle manual manipulation the aneurysm is displaced anteriorly to show its mobilization by serially clamping, severing, and ligating the related intercostal arteries.


Pericardium
Branch bronchi
Lower thoracic aorta
Esoph
J
Phrenic N
Diaphragm
K
Lower thoracic aorta
Esoph
L
Intercostal vessels

M The thoracic aorta cephalad to the aneurysm is doubly clamped (Potts coarctation clamps), and the site for its transection is indicated by the dotted line.

N, N' The cephalad transection of the aorta is completed (N), and the site for its caudad transection between the occluding clamps is shown (dotted line). The denudation of the musculature of the segment of the proximal portion of the esophagus that was adherent to the wall of the aneurysm is visible. As previously stated this could have been avoided by use of a "patch" graft of the wall of the aneurysm. The sites of the occlusion of the thoracic aorta are bypassed by the use of two large bore (12 gauge) needles which are connected through a Y-glass tube. The rubber tubing on the vertical stem of the Y glass tube is used both as an air vent and for the instillation of heparin–saline solution (100 mg. of heparin in 250 ml. of saline solution) to prevent clotting within the tubing. These illustrations were made during the course of an operation performed early in 1952, and this particular bypass technic is no longer used. Although hypothermia may be employed successfully in resections of aneurysm of the thoracic aorta, the use of a temporary bypass shunt graft is preferred (N). In this regard preserved homologous and heterologous grafts or cloth prostheses may be employed.

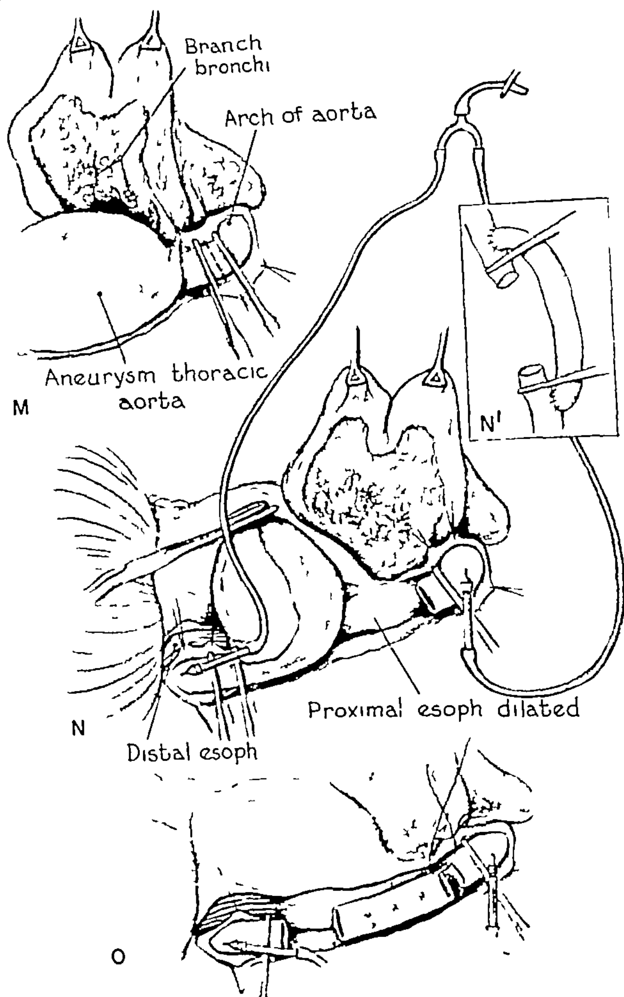
O The resection of the aneurysm is completed, and the insertion of a preserved homologous aortic graft is begun.

DISCUSSION—DR. MICHAEL E. DE BAKEY. The major problem in the resection of aneurysms of the descending thoracic aorta at this level is concerned with the necessity of temporarily arresting aortic circulation and the consequent effect of the increased vascular resistance upon the heart and the potential ischemic effect upon the spinal cord. Several methods may be employed to overcome these difficulties —induced general body hypothermia to reduce metabolic requirements and the use of various types of temporary intraluminal and extraluminal shunts to provide circulation to the distal segment. We have employed all of these methods and have found them to be fairly effective. The fact remains, however, that all of them are associated with certain disadvantages, and, for this reason, our efforts were directed toward the development of a more satisfactory method of overcoming some of these technical problems.

This method, which we have employed in about 50 cases with highly gratifying results, consists of an extracorporeal circuit using a pump. In this method, oxygenated blood is removed from the left atrium through a plastic canula (3/16 inch inside diameter) and pumped into the distal aorta through a plastic canula inserted through the left common femoral artery. The rate of flow is adjusted to the blood pressure in the segment of aorta above the aortic clamp attempting to maintain systolic pressure in this segment during the occlusion period at approximately 10 to 20 mm. Hg above normal pressure. Accordingly, from time to time during the period of occlusion, the rate of flow is adjusted to compensate for fluctuations in blood pressure varying in the range of 1000 to 2000 ml. per minute. Heparin 1 mg. per kg. body weight is administered intravenously before connecting the extracorporeal system, and a counteracting dose of protamine sulphate is administered after completing the procedure.

There are several other differences in technic which we consider preferable to that shown. First, in regard to the aortic occlusion clamps, we have found the Potts type of clamp to be unsatisfactory and prefer a clamp of our own design which is less likely to cause tearing or trauma to the aortic wall. Second, in regard to the graft, as indicated in the comment on resection of aneurysms of the abdominal aorta, we have completely abandoned the use of homografts and now prefer a flexible, crimped, knitted, dacron graft of our own design. Third, in regard to the anastomosis, we prefer to use a continuous through and through suture, as experience has demonstrated it to be functionally equally satisfactory to the so-called everting mattress suture, and technically it is easier and more rapidly performed.

Plate 249


Branch bronchi
Arch of aorta
Aneurysm thoracic aorta
M
N'
N
Proximal esoph dilated
Distal esoph
O

M. The thoracic aorta cephalad to the aneurysm is doubly clamped (Potts coarctation clamps), and the site for its transection is indicated by the dotted line.

N. The cephalad transection of the aorta is completed (N), and the site for its caudad transection between the occluding clamps is shown (dotted line). The denudation of the musculature of the segment of the proximal portion of the esophagus that was adherent to the wall of the aneurysm is visible. As previously stated, this could have been avoided by use of a "patch" graft of the wall of the aneurysm. The sites of the occlusion of the thoracic aorta are bypassed by the use of two large bore (12 gauge) needles which are connected through a Y glass tube. The rubber tubing on the vertical stem of the Y glass tube is used both as an air vent and for the instillation of heparin–saline solution (100 mg. of heparin in 250 ml. of saline solution) to prevent clotting within the tubing. These illustrations were made during the course of an operation performed early in 1952, and this particular bypass technic is no longer used. Although hypothermia may be employed successfully in resections of aneurysm of the thoracic aorta, the use of a temporary bypass shunt graft is preferred (N). In this regard preserved homologous and heterologous grafts or cloth prostheses may be employed.

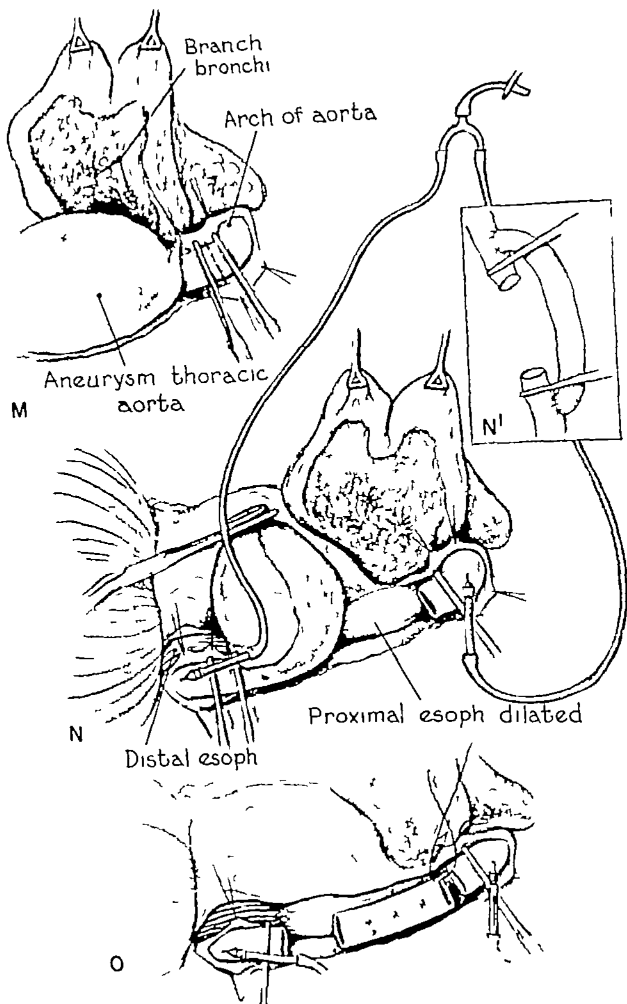
O. The resection of the aneurysm is completed, and the insertion of a preserved homologous aortic graft is begun.

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Plate 249


Branch bronchi
Arch of aorta
Aneurysm thoracic aorta
M
N'
N
Proximal esoph dilated
Distal esoph
O

O[1] Three cardinal guy sutures of 00000 arterial silk are inserted proximally and the medial suture is tied

O[2] The cardinal guy sutures are tied, and several of the intervening interrupted everting mattress sutures are inserted but not tied

O[3] O[4] The everting mattress sutures are tied, and traction on the long strands of the medial and lateral cardinal guy sutures is used (O) to facilitate the rotation of the aortic and graft segments for the insertion of the interrupted everting mattress and simple interrupted sutures posteriorly (O).

P P[1] In the event of a disparity in the size of the lumen of the segments to be anastomosed, a preliminary incision may be made in the anterior wall of the smaller vessel (P) to compensate for the discrepancy When the anastomosis is completed and the sutures are tied, the flangelike effect on the end of the smaller vessel is evident (P).

Q In this patient the original length of preserved homologous graft was too short. Accordingly a second and smaller graft segment was required to restore continuity of the thoracic aorta. The needle openings in the cephalad and caudad portions of the host aorta are occluded with interrupted sutures of silk (00000)

R S T U A Foley retention (5 ml.) catheter is used for water seal drainage of the pleural cavity (R) and a layer closure of the thoracic incision is performed using interrupted pericostal sutures of No 2 silk (R, S) for the rib approximation and interrupted sutures of silk (00 and 000) for closure of the muscles and skin (T U).

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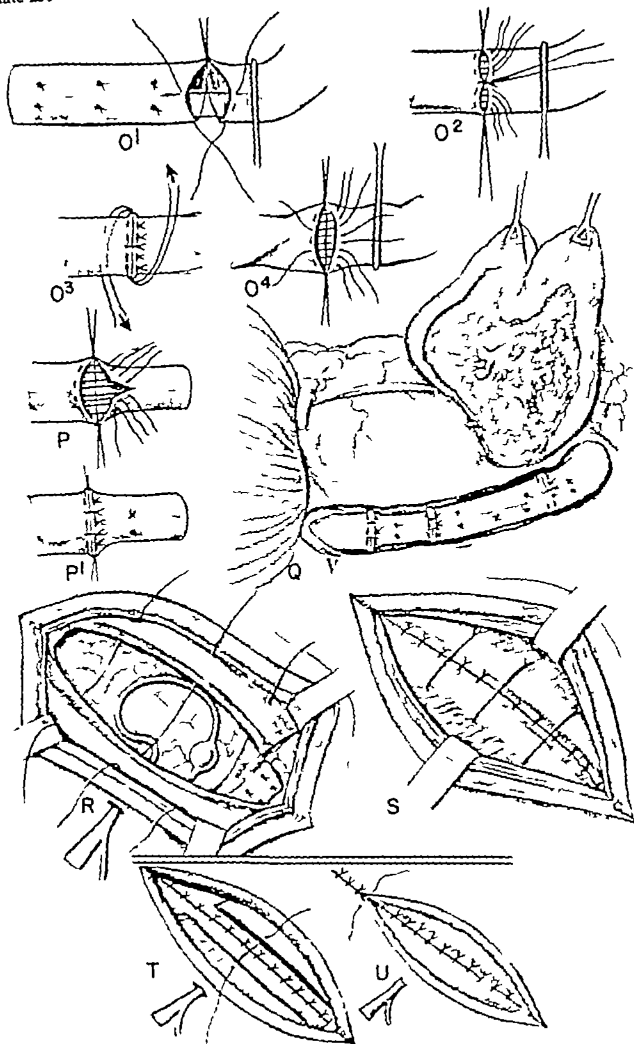
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Plate 250



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O The cardinal guy sutures are tied, and several of the intervening interrupted everting mattress sutures are inserted but not tied.

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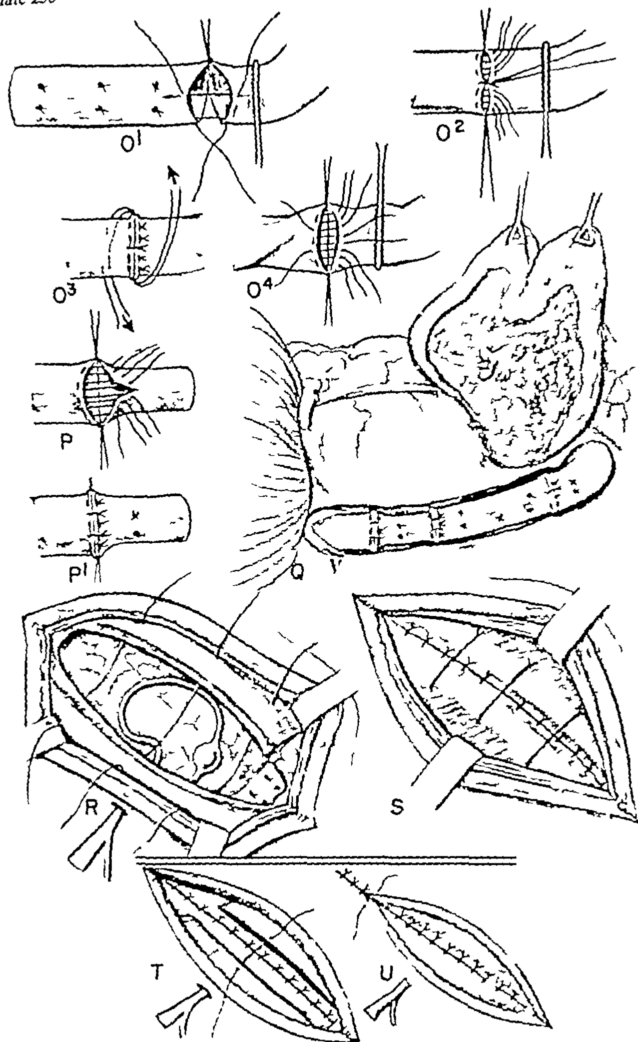
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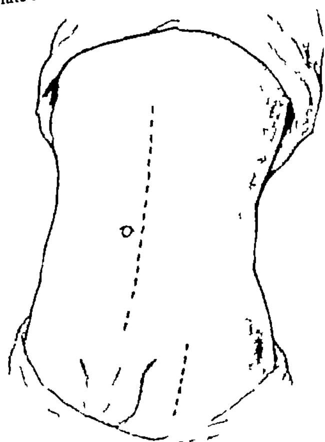
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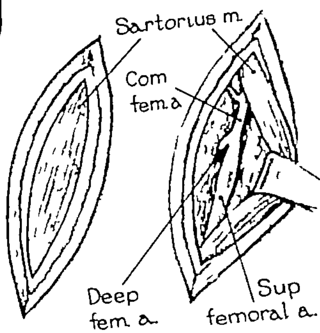
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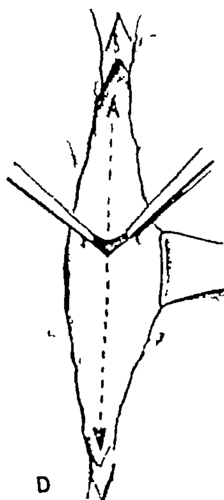
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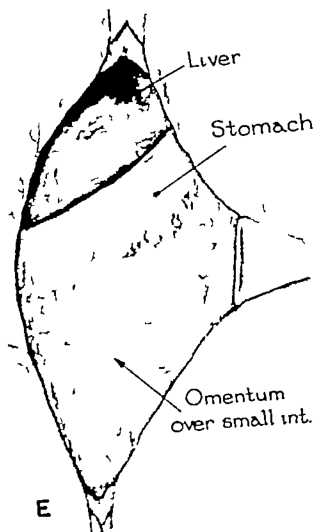
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Plate 251


A


Sartorius m.
Com
fem. a.
Deep
fem. a.
Sup
femoral a.
B
C


D


Liver
Stomach
Omentum
over small int.
E

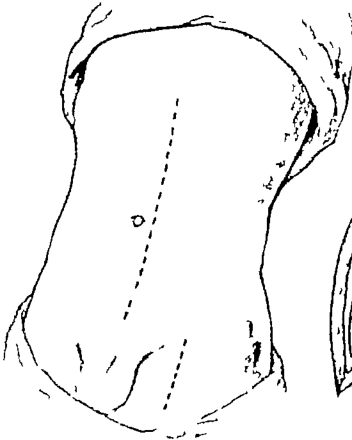
EXCISION OF AN ANEURYSM OF THE ABDOMINAL AORTA AND THE INSERTION OF A PRESERVED HOMOLOGOUS AORTIC GRAFT

A. The long left paramedian muscle retracting (lateral) incision, extending from the sym physis pubis to the left costochondral angle, and the short incision, overlying the left femoral artery are shown in dotted outline. In this particular patient the femoral arterial pulsation was excellent on the right and absent on the left. Accordingly it was deemed advisable to expose first the left femoral artery to determine the adequacy of the peripheral arterial "run off."

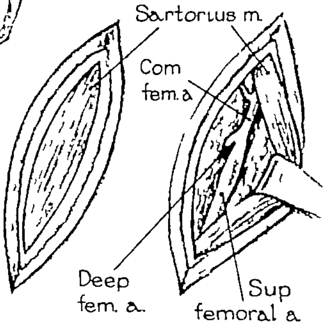
B, C. The thigh incision is deepened through the underlying fascial layer (B), and the sartorius muscle is retracted laterally to ex pose the common femoral artery and its deep (profunda) and superficial femoral branches (C). It may be observed that the common femoral artery is constricted and smaller in diameter than its superficial fem oral branch. On palpation, the walls of the superficial femoral artery were pliable and the lumen patent although no pulsations were present. In contrast the deep (profunda) and common femoral arteries were calcific throughout and their lumens completely ob- structed. It was evident at this time that the left external iliac branch of the bifurcation graft would of necessity be anastomosed to the left superficial femoral artery in the proximal portion of the thigh.

D The cut margins of the short incision in the anterior parietal peritoneum are grasped in clamps, and the extension of the incision both cephalad and caudad is indicated by the dotted lines.

E. The entrance into the peritoneal cavity is completed, and the wound margins are re- tracted to expose the related subjacent in traperitoneal viscera.

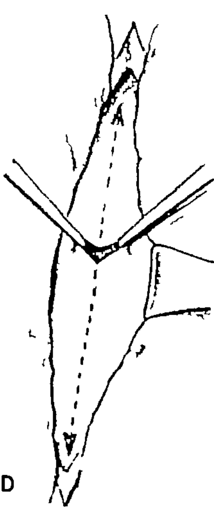


A

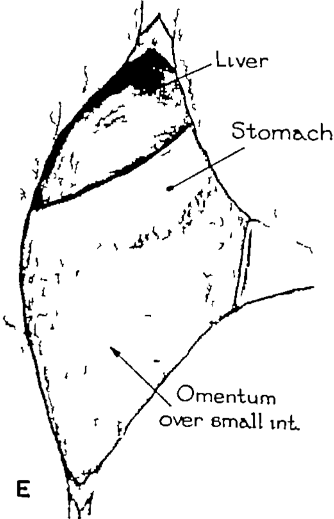

Sartorius m.
Com fem. a.
Deep fem. a.
Sup femoral a.

B

C



D

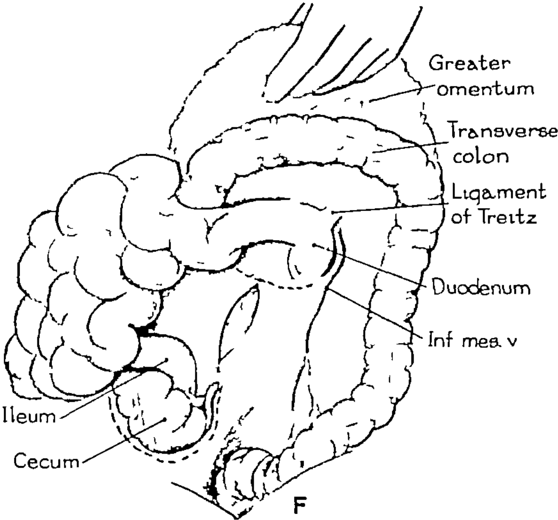

Liver
Stomach
Omentum over small int.

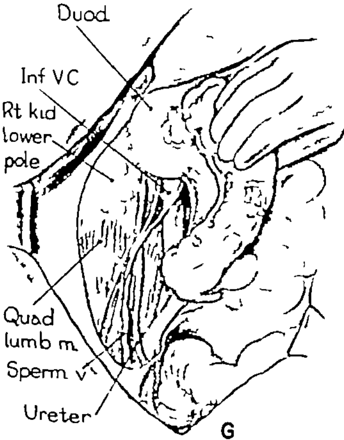
E

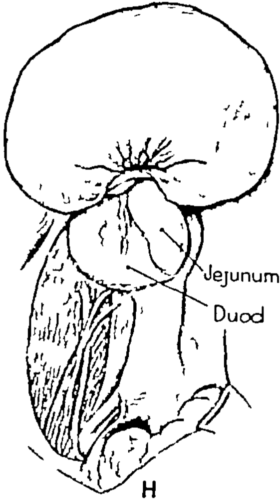
F The omentum and transverse colon are elevated, and the completed incision in the posterior peritoneal attachment of the small bowel mesentery is visible. The extension of this incision around the cecum and upward along the peritoneal attachments of the ascending colon is shown in dotted outline. The peritoneal incision for mobilization of *the duodenum and its horizontal extension* (dotted line) along the inferior border of the fourth portion of the duodenum are also visible. The relation of the inferior mesenteric vein to the ligament of Treitz and the duodenojejunal junction is depicted.

G The right side of the colon is mobilized, and the related structures posteriorly are shown. Although this mobilization of the colon is not an essential part of the operation it has proved a technical aid in the exposure of aneurysms of the abdominal aorta.

H. The mobilized small bowel and colon are enclosed in a rubber bag (Lahey) and placed outside of the abdomen on the lower portion of the patient's chest. Before placing *the bowel in the bag it is important to examine* carefully the raw surfaces of the mesenteric attachments for bleeding sites. The failure to recognize and control bleeding may cause a loss of 800 to 1000 ml. of blood into the bag. In our own experience, this occurred on one occasion. The incision for severance of the remaining peritoneal attachment of the fourth portion of the duodenum is depicted (dotted line).


Greater omentum
Transverse colon
Ligament of Treitz
Duodenum
Inf mes v
Ileum
Cecum
F


Duod
Inf VC
Rt kid lower pole
Quad lumb m
Sperm v
Ureter
G

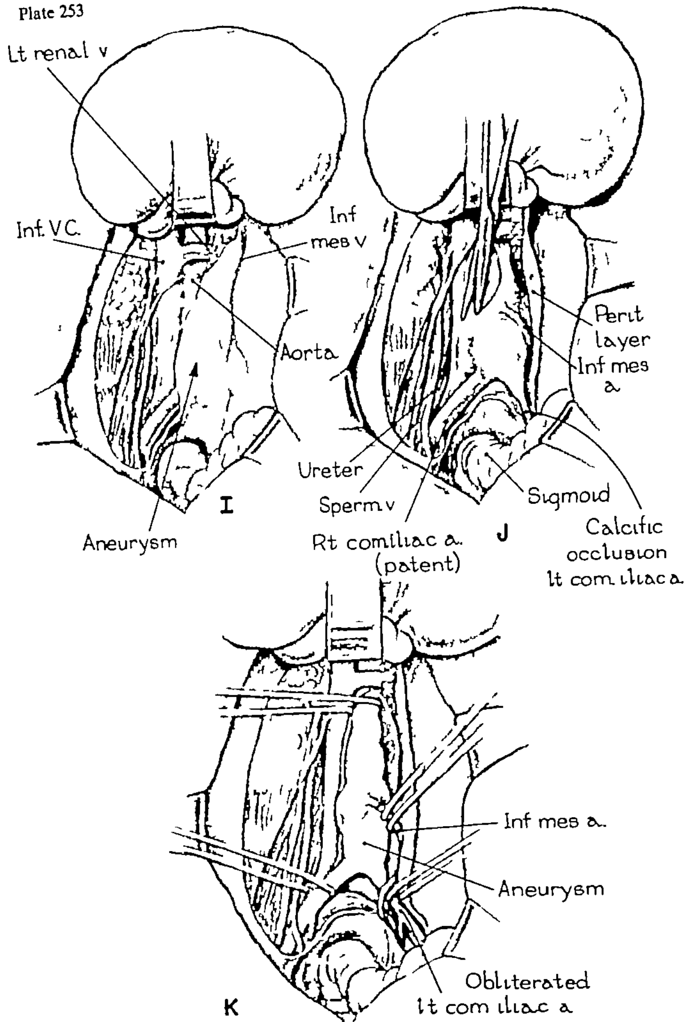

Jejunum
Duod
H

I. The mobilized duodenum is retracted upward to expose the left renal vein which crosses over the abdominal aorta just proximal to the aneurysm and enters the inferior vena cava. The outline of the aneurysm beneath the posterior parietal peritoneum is visible.

J. The overlying posterior parietal peritoneum is elevated from the surface of the aneurysm which is mobilized by scissor dissection from its attachment to the adjacent inferior vena cava. In some instances, the aneurysm is inextricably adherent to the inferior vena cava, and its separation without entrance into the aneurysm or the vena is impossible. Under such circumstances, further dissection in this area is discontinued until the aorta proximally and its common iliac branches distally are cross-clamped. The aneurysm is then incised and its contents evacuated. Bleeding from the orifices of the lumbar vessels entering the aneurysm posteriorly is controlled by suture ligatures of silk, and the wall of the aneurysm is tailored as it is excised by scissor dissection to leave a "patch graft" at its site of adherence to the inferior vena cava. This technic applies in particular to the treatment of the acutely ruptured aneurysm. To persist in the attempt to dissect an adherent aneurysm from the vena cava is not only time-consuming but may result in serious and even fatal hemorrhage. The site of the segmental occlusion of the left common iliac artery is visible. In this patient, four aneurysmal dilatations, the lowermost being the largest, were present in the segment of the aorta below the left renal vein. Furthermore, a dissection plane between the aorta and the inferior vena cava, which facilitated the separation of these structures, was easily obtained.

K. The dissection of the aneurysm from the inferior vena cava is completed. The aorta proximally and the common iliac arteries distally are encircled by cotton tapes. The inferior mesenteric artery is occluded proximally with a ligature of silk (00) and distally by two clamps between which the artery is subsequently severed. Each clamp is then replaced by a suture ligature of 000 silk.

Plate 253



Lt renal v
Inf VC
Inf mes v
Aorta
Aneurysm
I
Perit layer
Inf mes a
Ureter
Sperm v
Sigmoid
Rt com iliac a (patent)
J
Calcific occlusion lt com iliac a
Inf mes a
Aneurysm
Obliterated lt com iliac a
K

O. The left common iliac artery and the left external iliac artery are severed proximally and distally respectively to the internal iliac artery and the distal transected end of the external iliac artery is partially withdrawn beneath the inguinal ligament into the thigh. The T-shaped appearance formed by the ligated stumps of the common and external iliac arteries in relation to the obliterated internal iliac artery is visible.

P The withdrawal of the distal segment of the left external iliac artery beneath the inguinal ligament is completed, and the superficial femoral artery is cross-clamped with a straight Potts clamp

Q The obliterated left common iliac artery is severed just distal to the aortic bifurcation, and noncrushing clamps (Potts) are applied to the right common iliac artery and to the aorta proximal to the uppermost aneurysmal dilatation The dotted lines indicate the respective sites for transection of the aorta proximally and the right common iliac artery distally

R. The common iliac arterial branches of the preserved homologous bifurcation graft are clamped (Potts clamps) and elevated to show the initiation of the anastomosis between the aorta and the homologous graft by the insertion of two silk (00000) sutures in the midline posteriorly

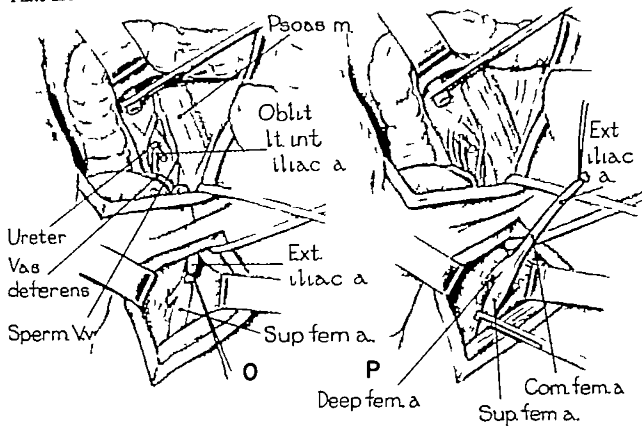
R[1] R[2] R[3] The sutures posteriorly are tied, and one of the sutures proceeds to the patient's left (R) and the other to the patient's right (R[2]) to complete the insertion of the posterior layer of the anastomosis (R[3]). The insertion of each suture is begun on the graft side so that the needle when inserted on the host aortic side impinges the intima plaques which are usually present against the underlying coats of the aorta.

Discussion—Dr. De Bakey (cont.)

segment of the graft to the right iliac artery After completing this latter anastomosis, the occluding clamp on the right iliac artery would be removed and an effort made to obtain retrograde flushing of the vessel to remove any debris or clots that may have accumulated distal to the clamp. After good retrograde blood flow was assured, an occluding clamp would be applied to the right iliac segment of the graft just distal to the bifurcation and the aortic clamp released for a few seconds to flush out the aorta through the graft and the remaining open end of the left iliac segment of the graft. This assures removal of any debris and clots that may have accumulated in the blind segment of the aorta proximal to the clamp Following these maneuvers, the occluding clamp on the right iliac segment of the graft is removed and applied to the left iliac segment of the graft just distal to the bifurcation. The aortic clamp is then slowly released, permitting circulation to be restored through the graft and into the right lower extremity

Attention may now be directed toward anastomosis of the left iliac segment of the graft. In this case, since the left common iliac artery was occluded, it is necessary to extend the left iliac segment of the graft beyond this level. Under these circumstances, our experience has led us to use the bypass principle. The occluded segment of the left iliac artery is allowed to remain undisturbed, and, instead of resecting the common femoral artery we would probably have performed an endarterectomy in this region and attached the graft as an end-to-side anastomosis. This has the advantage of being a simpler and less time-consuming procedure and has proved effective in our experience. Significantly we have never encountered gangrene as a complication of this operation.

Plate 255



Aneurysm
Obliterated
com iliac a.
Q
Rt com
iliac a.
(patient)
Graft
R
R¹
Aorta
Graft
R²
R³
Aorta

R[4] R[5] S. The graft is displaced downward, and the insertion of the anterior layer of the anastomosis is continued from either side (R R[4]) to meet in the midline anteriorly where the sutures are tied together (S) As previously stated, the insertion of the needles on the host aortic side anteriorly is again in such a manner as to impinge the intima coat against the underlying coats of the aorta.

T The external iliac segment of the aortic bifurcation graft was too short to reach to the level of the superficial femoral artery Accordingly the unused portion of the right common iliac artery of the graft and its bifurcation was used on the left side to gain the necessary length to complete the anastomosis with the superficial femoral artery The substitute graft segment was inserted in a reversed direction, and its terminal external iliac segment was anastomosed to the terminal portion of the left external iliac artery The terminal segment of the common iliac artery (right) of the substitute graft segment is in readiness to be anastomosed to the superficial femoral artery

U V The three cardinal guy sutures of silk between the common iliac artery segment and the superficial femoral artery are inserted (U), and the end-to-end anastomosis in the proximal portion of the left side is completed (V). In this particular patient, anastomosis of the graft with the internal iliac arteries was not required. However in the excision of aneurysms of the abdominal aorta in which transection distal to the common iliac arteries is done, anastomosis of the internal iliac arteries, if patent, to the graft is practiced. In one patient in whom ligation rather than anastomosis of the internal iliac arteries was done two large areas of tissue necrosis of the tissues deep within the buttocks with secondary skin necrosis occurred. Furthermore, in some patients, compromise of the blood supply to a segment of the colon may result from failure to anastomose the graft with the internal iliac arteries

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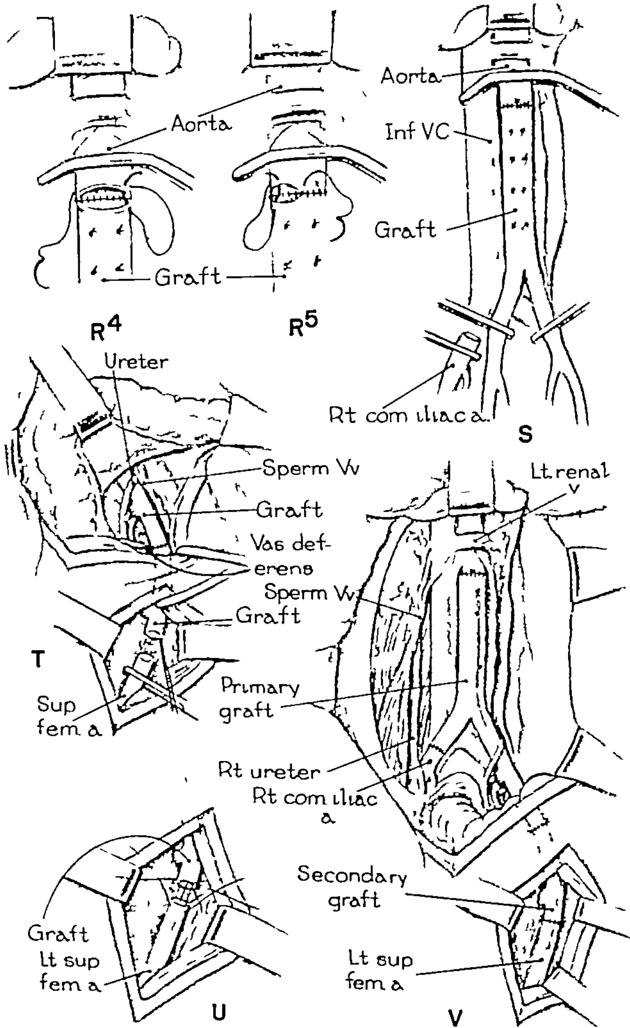
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Plate 256


Aorta
Graft
R4
R5
Aorta
Inf VC
Graft
Rt com iliac a
S
Ureter
Sperm Vv
Graft
Vas deferens
Sperm Vv
Graft
T
Sup fem a
Lt renal v
Primary graft
Rt ureter
Rt com iliac a
Graft
Lt sup fem a
U
Secondary graft
Lt sup fem a
V

W X. The insertion of the preserved homologous bifurcation graft and the substitute extension graft is completed. The anastomosis on the right side is to the common iliac artery and on the left to the superficial femoral artery in the thigh (W). The closure of the incision in the proximal portion of the left thigh is completed, and the abdominal wound is being closed, using both interrupted mattress sutures and simple interrupted sutures of 00 silk for the peritoneum and interrupted sutures of 00 silk for the anterior rectus sheath (X) The skin incision is subsequently closed with interrupted sutures of 00 silk.

The patient, a 55-year-old white man, was admitted to the hospital with the history that, during the preceding year pain in the left leg on walking, relieved by rest, was noted. The symptoms persisted, and, during the two months prior to admission to the hospital, pain in the left hip and the low back was observed. Examination at this time demonstrated a palpable pulsatile mass in the lower abdomen and the absence of pulsations in the left femoral artery The pulsations in the right femoral artery were normal. A diagnosis of an aneurysm of the abdominal aorta with segmental occlusion of either or both the left common and external iliac artery was made. At operation, multiple (four) relatively small aneurysms of the abdominal aorta were present in conjunction with atherosclerotic obliteration of the left common iliac, the internal iliac, the external iliac, and the common and profunda femoral arteries. The local pathologic findings in the aorta and its peripheral arterial branches on the left side were consistent with the diagnosis of *juvenile arteriosclerosis* (Leriche). The pathologic findings present accounted for the relative ease with which the involved segment of the abdominal aorta was freed from the adjacent inferior vena cava. Following the insertion of the preserved homologous aortic graft as depicted in the illustrations, an excellent arterial pulsation was restored in the left superficial femoral artery The subsequent postoperative course was without incident, and the patient was discharged from the hospital in satisfactory condition on the 16th day after operation.

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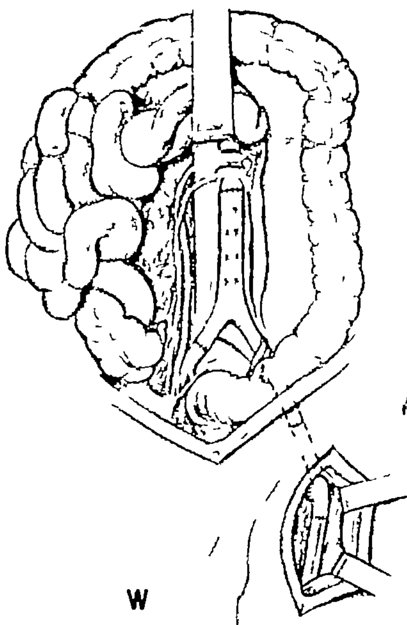
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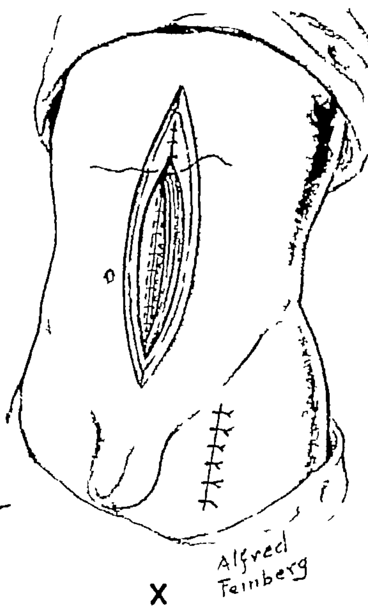
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Plate 257





W X. The insertion of the preserved homologous bifurcation graft and the substitute extension graft is completed. The anastomosis on the right side is to the common iliac artery and on the left to the superficial femoral artery in the thigh (W). The closure of the incision in the proximal portion of the left thigh is completed, and the abdominal wound is being closed, using both interrupted mattress sutures and simple interrupted sutures of 00 silk for the peritoneum and interrupted sutures of 00 silk for the anterior rectus sheath (X) The skin incision is subsequently closed with interrupted sutures of 00 silk.

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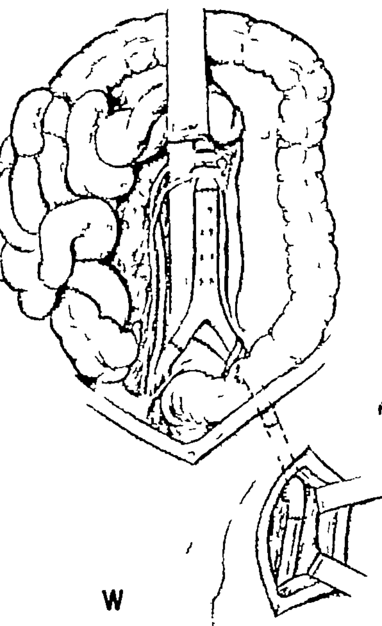
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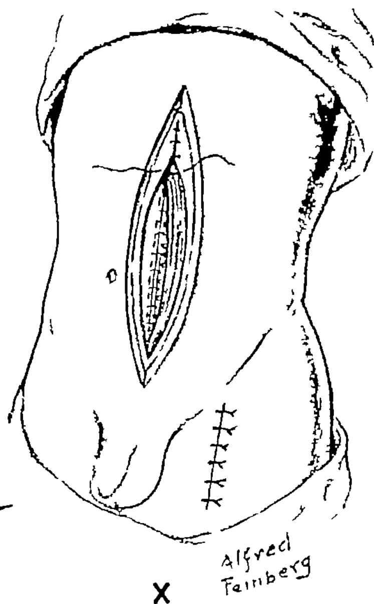
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Plate 257





EXCISION OF AN ANEURYSM OF THE POPLITEAL ARTERY AND THE INSERTION OF AN ALCOHOL (70 PER CENT) PRESERVED HOMOLOGOUS AORTIC (THORACIC) GRAFT

A. The incision employed, depicted in dotted outline, is preferred to one of the midline longitudinal type

B. The mobilized flaps of skin and subcutaneous fatty tissue are retracted to expose the posterior crural fascia and the underlying muscles The perforation of the crural fascia by the short saphenous vein (saphena parva) is visible

C, D E. The incised margins of the linear incision in the posterior crural fascia are retracted in clamps (C) and, by scissor dissection in the underlying tissue, the popliteal vein and the entrance of its tributary the short saphenous vein, are demonstrable. A portion of the tibial nerve and its branches, as well as portions of the surrounding musculature are also delineated (D E)

F The dissection is continued within the deeper tissue, and the superior pole of the popliteal artery and the outline of its "dumbbell" aneurysm immediately distal are visible. A greater length of the tibial nerve is now exposed, and its branch to the medial head of the gastrocnemius muscle may be seen arched across the lower portion of the popliteal vein.

DISCUSSION—DR. ROBERT R. LINTON Popliteal aneurysms, whether of luetic, arteriosclerotic, or traumatic origin, should be excised as described and illustrated in the text because they are a risk to both limb and life if not treated. Secondary thrombosis eventually occurs if they are left in place, with resulting gangrene of the leg necessitating amputation in the majority of cases. This can be prevented in all cases by resection of the aneurysm with the insertion of some type of graft to restore arterial continuity It has been found possible to excise these aneurysms safely prior to grafting procedures, by first protecting the limb by a preliminary lumbar sympathetic ganglionectomy

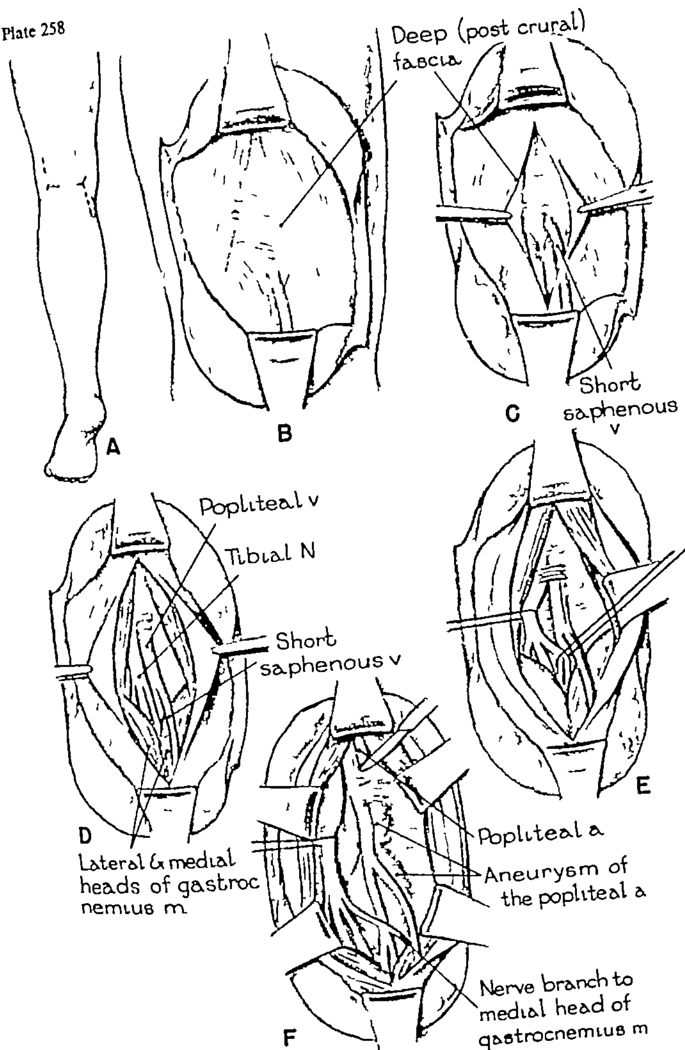
In more recent years, it has been possible, with the advance in the technic of arterial grafting procedures, to restore arterial continuity in these cases by the implantation of some type of graft By this newer method, it has not been necessary to perform the lumbar sympathectomy in the majority of cases. In addition, the intermittent claudication which inevitably followed the resection of the aneurysm has been prevented by the restoration of arterial continuity so that, in general, the method as described and illustrated is to be highly recommended

It is believed that some of the details of the technic, as shown in the illustrations can be improved upon in the performance of this procedure. In addition, the type of homograft that is recommended is open to some question The type of incision used to expose a popliteal aneurysm has never been completely agreed upon The S-type that is shown in Plate 258A is recommended by some, but it is the opinion of many vascular surgeons that the best incision for operations on major blood vessels is an incision which parallels the course of the blood vessel. Therefore if the S-type of incision is to be used, it would seem better if the upper extension of it were on the inner side of the thigh rather than on the outer as is shown since that is the direction and course of the popliteal and femoral arteries My preference, on the other hand, is a longitudinal incision without the S-type of configuration This has been used in several hundreds of cases and has not been the cause of any contracture difficulty providing the incision is resutured properly and the limb is placed in a posterior splint for a week after the operative procedure.

Retraction of the posterior tibial and peroneal nerves, as shown in Plate 258E, can be less traumatic if a thin piece of Penrose drain is used instead of the ligatures as shown. It is frequently necessary especially with large aneurysms, to divide the nerve supply to either head of the gastrocnemius muscle. If such is the case there should be no hesitancy in doing this because it results in little, if any incapacity Rarely is it necessary to sacrifice the nerve supply to both heads of this muscle.

The popliteal vein is beautifully shown in the Plate 259G H, and I, and, if possible, preservation and utilization of this vein as an autogenous venous graft to replace the portion of popliteal artery that has to be resected is recommended In some instances, this is not possible because the vein is so firmly adherent to the aneurysm it cannot be dissected free without injuring it. When this can be ac

Plate 258


Deep (post crural) fascia
Short saphenous v
Popliteal v
Tibial N
Short saphenous v
Lateral & medial heads of gastroc nemius m
Popliteal a
Aneurysm of the popliteal a
Nerve branch to medial head of gastrocnemius m
A
B
C
D
E
F

G H. The operative field is more widely exposed, and the bifurcation of the branch of the tibial nerve to the medial head of the gastrocnemius muscle may be seen. The popliteal vein, inextricably adherent to the posterior wall of the aneurysm, was removed with the specimen. Accordingly its lowermost tributaries and the short saphenous tributary were doubly clamped, severed, and ligated (H) In doing this care was observed to avoid injury to the overlying nerve branch to the gastrocnemius muscle.

I. Scissor dissection is continued to mobilize completely the "dumbbell" aneurysm from its surrounding structures.

J J^1 J^2 In mobilizing the aneurysm, it is deflected first to one side (J) and then the other (J) to expose the arterial branches which are doubly clamped, severed, and ligated (00 silk) The majority of the arterial branches were in the lower aneurysmal dilatation of the popliteal artery (J^2)

K. The aneurysm is completely mobilized, and its superior pole is encircled with a ligature of silk (0) The cephalad portion of the popliteal vein is doubly clamped prior to its severance and ligation (00 silk)

Discussion—Dr. Linton (cont.)

complished, however the popliteal vein is believed to make the most satisfactory reconstruction graft that can be found. In other instances, it is recommended that the saphenous vein be utilized if it is found to be of large enough caliber Autogenous blood vessels are found to serve much more satisfactorily than any other type of arterial replacement, whether it be homologous venous or arterial grafts, or artificial prostheses.

In reviewing the illustrations, there is one very important step in the procedure which is not shown until Plate 260L. This is the application of an occlusive clamp to the popliteal artery distal to the aneurysm. It is recommended that one should be applied before any dissection of the aneurysm is commenced because, if it is not, there is great danger of breaking off portions of an intraaneurysmal clot and causing embolic occlusions of the arteries distal to the aneurysm with resultant serious impairment of the circulation to the lower leg. In my opinion the best type of clamp is a small "bulldog" one it should be applied to the popliteal artery just distal to the aneurysm before carrying out any extensive dissection elsewhere

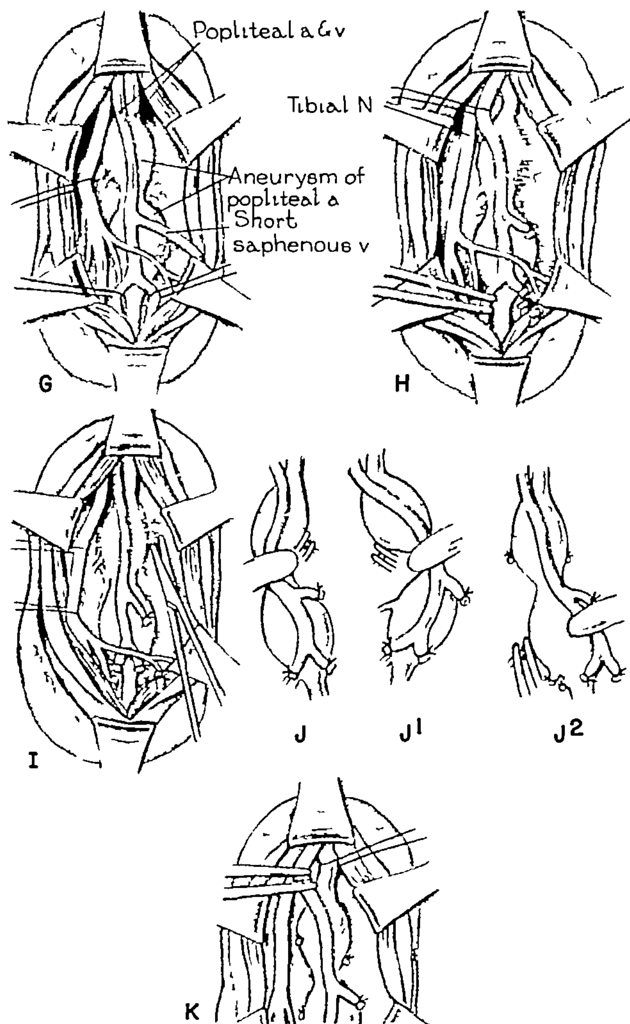
There are various technics of implanting a venous autograft, an arterial homograft, or an artificial synthetic prosthesis The method illustrated in the plates is one that has been discarded because, with the use of a running suture as demonstrated, stenosis inevitably results at the site of the anastomosis. Instead of the method as depicted, it is recommended that longitudinal slits be made in the host artery and the graft, which permit a much more easily accomplished end-to-end anastomosis without stenosis, even with a running over and over suture. This method of anastomosis also permits one to utilize a blood vessel of smaller caliber than one can use by the end-to-end technic as shown in the illustrations.

The utilization of aortic grafts preserved in alcohol is open to some question. The chief advantage is the availability of them. In the majority of cases, it is believed that a thoracic aorta is much too large in caliber to utilize satisfactorily for the replacement of a peripheral artery such as the popliteal. This may be possible as the result of the sclerosing and shrinking action of the alcohol on the aortic graft.

Drainage of the operative field is of doubtful value, and especially so if one is utilizing a homograft, because of the danger of infection. It is recommended that extreme care should be exercised to obtain complete hemostasis so that drainage will not be necessary After closure of the incision and the application of a sterile gauze dressing, a posterior splint of either wood or plaster should be applied to keep the knee in extension and so prevent a contracture in the scar It is recommended that it should not be removed until the fifth postoperative day

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Popliteal a & v
Tibial N
Aneurysm of
popliteal a
Short
saphenous v
G
H
I
J
J1
J2
K

L. The superior and inferior poles of the "dumbbell" aneurysm are clamped (Potts clamps) prior to transection (dotted lines) and removal of the aneurysm with the attached popliteal vein.

M. In this patient, the diameters of the lower portion of the femoral artery and the distal segment of the popliteal artery were extremely large and required the use of the thoracic segment of an alcohol (70 per cent) preserved homologous aortic graft to obtain a proper fit. The three cardinal guy sutures (00000 arterial silk) are inserted, one posteriorly and one at either lateral angle, but not tied

N N[1] N[2] N[3] N[4] N[5] The guy sutures are tied, and the suture strands are left long (N) The lower end of the graft is elevated to show the start of the posterior layer of the anastomosis (N) One of the lateral angle sutures is inserted as a continuous over and over suture to the midline posteriorly where it is tied to the free end of the posterior cardinal guy suture (N[3]) The needle attached strand of the posterior cardinal guy suture is similarly continued as an over and over suture (N) and tied to the free end of the remaining lateral angle cardinal guy suture (N N[5]).

O O[1] The aortic (thoracic) graft segment is turned downward to show the insertion of the sutures forming the anterior layer of the anastomosis. The needle attached strand of one of the lateral angle cardinal guy sutures (N[5]) is continued anteriorly as a continuous over and over suture (O) and tied to the free end of the opposing lateral angle guy suture (O) The needle is inserted from the "inside out" on the host popliteal artery to impinge the calcific plaques which are frequently present in the intima against the underlying coats of the vessel.

O[2] The proximal anastomosis is completed, and the three cardinal guy sutures are similarly inserted distally but not tied

O[3] The use of the free ends of the lateral angle cardinal guy sutures to rotate the graft and arterial segments for the insertion of the posterior layer of sutures, as previously depicted, is shown.

P The insertion of the thoracic segment of the alcohol (70 per cent) preserved homologous graft to restore continuity of the popliteal artery is completed, and its relation to the surrounding structures is visible

Q A rubber tissue drain is inserted into the popliteal fossa, and the incision in the posterior crural fascia is closed with interrupted sutures of 000 silk. The closure of the skin incision and the application of a sterile gauze compression dressing complete the operation.

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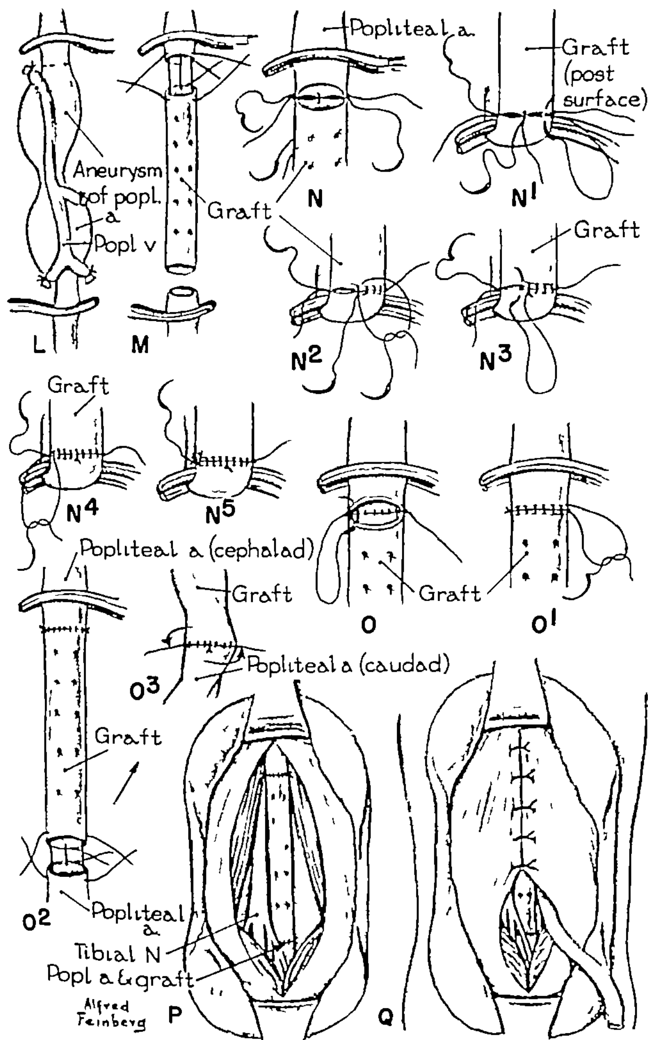
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Popliteal a.
Graft (post surface)
Aneurysm of popl. a
Popl v
Graft
L
M
N
N1
Graft
N2
N3
Graft
N4
N5
Popliteal a (cephalad)
Graft
Graft
O
O1
O3
Popliteal a (caudad)
Graft
O2
Popliteal a.
Tibial N
Popl a & graft
Alfred Feinberg
P
Q

EXCISION OF AN ANEURYSM OF THE COMMON CAROTID ARTERY AND THE INSERTION OF AN AUTOGENOUS VEIN GRAFT

A. The oblique cervical incision paralleling the anterior border of the left sternomastoid muscle is indicated by the solid line.

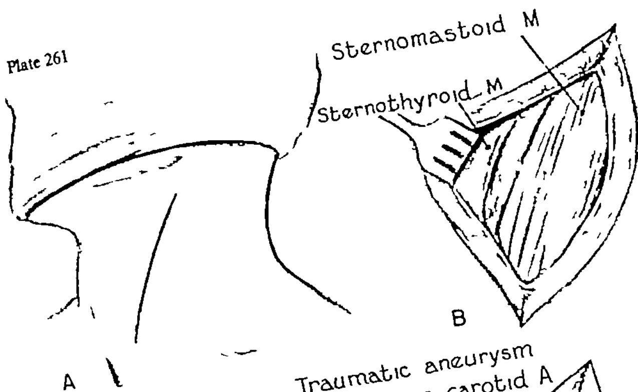
B. The incision is deepened through the subcutaneous fatty tissue, the platysma muscle, and the anterior layer of the deep cervical fascia to expose portions of the sternothyroid and sternomastoid muscles.

C. The muscles are retracted and the summit of the traumatic aneurysm of the left common carotid artery is visible beneath the retracted margin of the sternomastoid muscle.

D The aneurysm and its collateral arterial branches are mobilized from the surrounding tissues by a combination of sharp and blunt dissection The common carotid artery both cephalad and caudad to the aneurysm, is encircled by cotton tapes for traction and, if necessary for temporary mechanical occlusion of the arterial lumen. Guy sutures of silk (000) for traction are also inserted in the wall of the aneurysm.

E, F The collateral arterial branches are ligated and severed, and mobilization of the aneurysm is continued by scalpel dissection. The adherence of the aneurysm to the internal jugular vein is visible.

Plate 261



Traumatic aneurysm
left common carotid A

C

D

Vagus N

Int jugular V

E

Thyroid gland

F

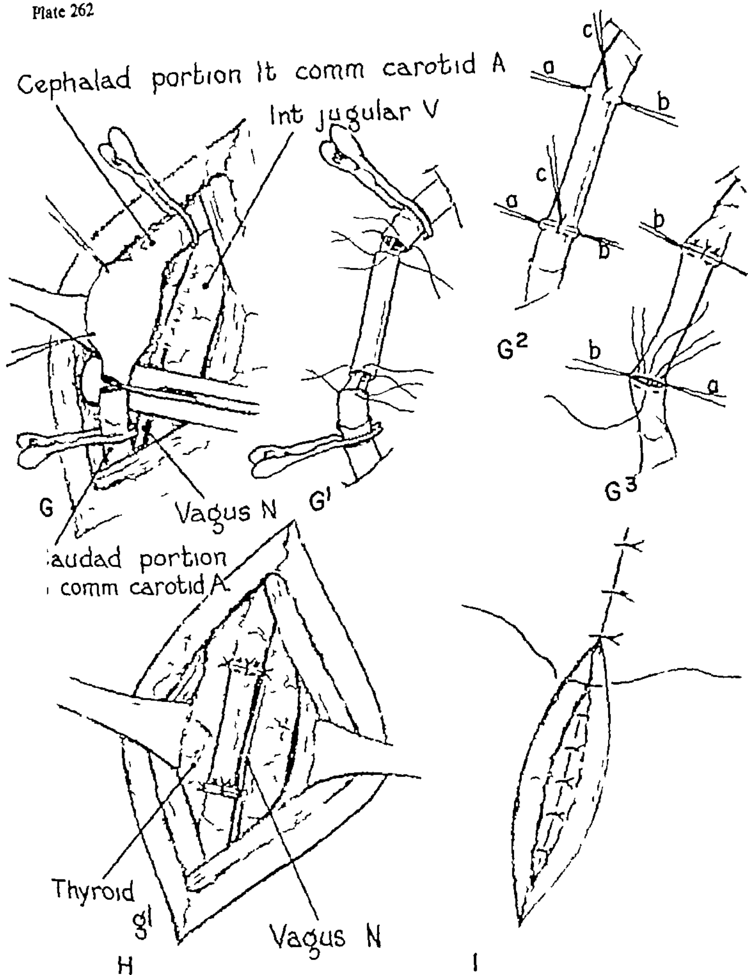
G The mobilization of the aneurysm and portions of the common carotid artery both cephalad and caudad, is completed. The common carotid artery is occluded by Potts serrafine or "bull dog" clamps on either side of the aneurysm preparatory to its excision A cuff of the adventitia layer of the artery is removed at each site of election for its transection. This maneuver is more readily accomplished with the artery in continuity as depicted. The carotid artery caudad is being transected with a scalpel over an underlying sterile tongue depressor The site of arterial transection cephalad is indicated by the dotted line.

G^1 G^2 G^3 The excision of the aneurysm is completed, and the free graft of saphenous vein, which is reversed (cephalad portion is caudad), is aligned between the transected ends of the common carotid artery by three equidistantly placed cardinal guy sutures (00000 silk), which are inserted but not tied (G^1) The guy sutures are tied (G^2) and the long strands are used for traction to facilitate the rotation of both the graft and the transected ends of the carotid artery for the insertion of the silk (00000) sutures posteriorly (G^3).

H. The excision of the traumatic aneurysm of the left common carotid artery and the insertion of the reversed free graft of the great saphenous vein are completed. The relation of the graft to the surrounding structures is visible.

I. The anterior layer of the deep cervical fascia and then the skin are closed with interrupted sutures of 000 silk.

Plate 262


Cephalad portion lt comm carotid A
Int jugular V
G
Vagus N
G'
Caudad portion
comm carotid A
c
a
b
c
a
b
G²
b
b
a
G³
Thyroid gl
Vagus N
H
I

A. The incision for the removal of a free graft of the great saphenous vein is shown by the solid line The center of the incision is located at a position 1 inch below the inguinal ligament and 1 inch medial to the femoral arterial pulsation. This has proved an excellent site for the exposure of the cephalic portion of the saphenous vein.

B. The skin incision is deepened to expose the deep layer of the subcutaneous fascia beneath which the saphenous vein is located.

C. The deep layer of the subcutaneous fascia is incised, and the saphenous vein is isolated from the surrounding fatty areolar tissue. A guy suture of silk (00000) is inserted in the adventitia coat of the saphenous vein as a landmark for its proximal level of transection. The vein is doubly clamped The site for transection of the intervening segment is indicated by dotted lines.

D. The resection of the segment of vein to be used as a free autogenous graft is being completed.

E, F G. The transected ends of the saphenous vein are occluded proximally and distally with ligatures of 000 silk (E), and a layer closure of the wound is performed, using interrupted sutures of 000 silk (F G)

H. The length of free graft of saphenous vein obtained is shown. Prior to its insertion, the vein graft is washed thoroughly in a heparin–saline solution (100 mg. of heparin and 250 ml of normal saline solution).

It should be emphasized that the cephalic portion of the great saphenous vein, because of the comparable diameter of its lumen, is an ideal donor for restoration of continuity of the common carotid artery

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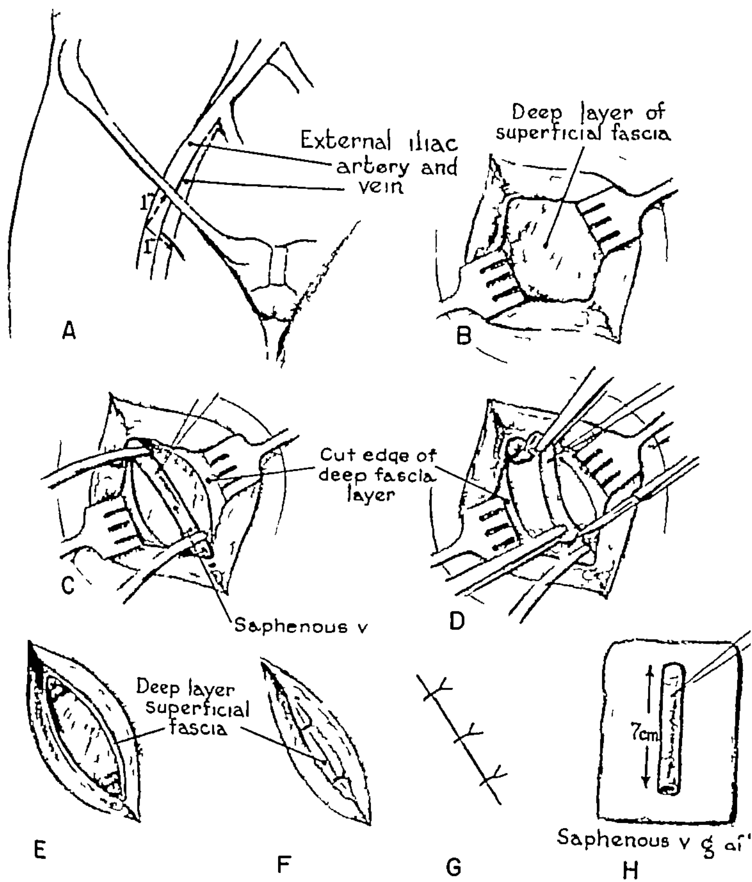
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External iliac
artery and
vein
A
Deep layer of
superficial fascia
B
Cut edge of
deep fascia
layer
C
Saphenous v
D
Deep layer
superficial
fascia
E
F
G
7cm
Saphenous v
H

RESTORATION OF PERIPHERAL ARTERIAL CONTINUITY BY RESECTION AND GRAFT (VEIN) REPLACEMENT OR A SHUNT BYPASS

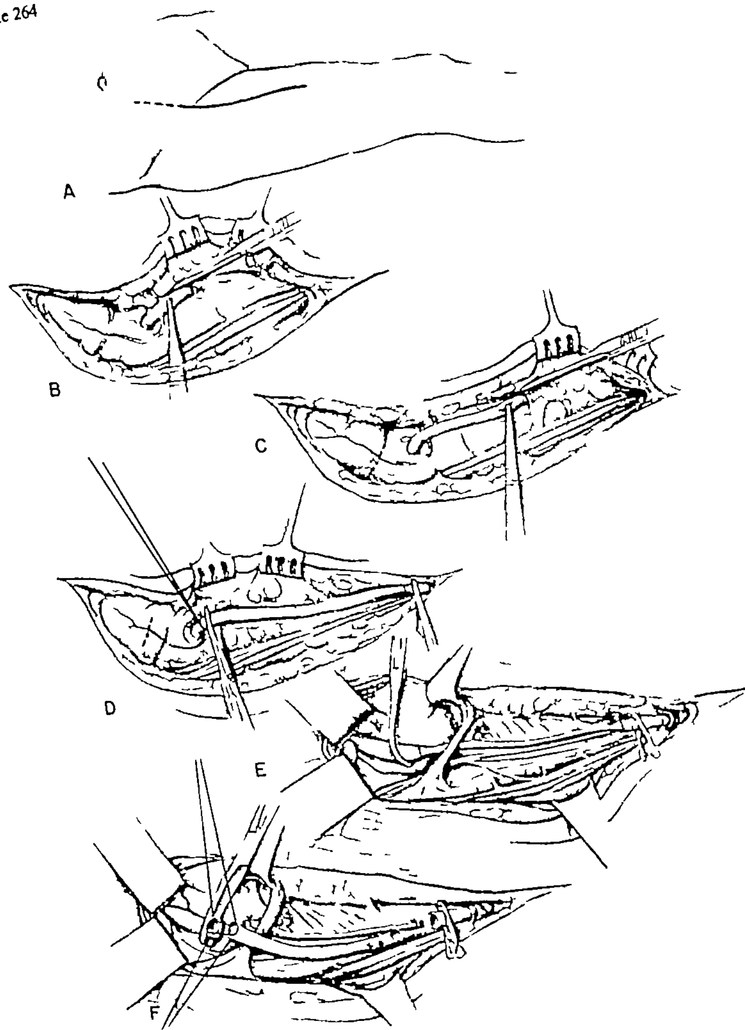
A. The anterior thigh incision employed (solid line) and its abdominal extension (dotted line) are depicted.

B C, D The long saphenous vein is mobilized by sharp dissection from the subcutaneous fatty tissue layer medially (B C), and a 16-cm. length of the vein is removed as indicated (D) Either a suture knot is placed in the adventitia coat of the vein or the ligated stumps of the tributary veins are used as landmarks to determine the cephalad and caudad ends of the vein. The vein is then immersed in a solution of heparin and saline (100 mg. of heparin in 250 ml. of saline) until ready for use. The direction of the vein is always reversed prior to insertion to prevent the possibility of an obstruction to the flow of blood caused by competent valves within its lumen.

E. The long length of the constricted and obliterated arterial segment involving the distal portion of the external iliac artery the common femoral artery and the proximal two-thirds of the superficial femoral artery is visible. The patent arterial segments cephalad and caudad are occluded with clamps, and the intervening segment is transected at the sites indicated (dotted lines).

F Preparatory to the performance of the blood vessel anastomosis 10 ml. of the heparin-saline solution is injected into the lumen of the artery caudad. The direction of the vein graft is reversed and the caudad end is now cephalad. Two of the three equidistantly placed cardinal guy sutures which are used to approximate the ends of the vessels are inserted but not tied. The vein graft shown anterior to the inguinal ligament is subsequently withdrawn beneath it immediately after the completion of the cephalad end of the anastomosis.

Plate 264

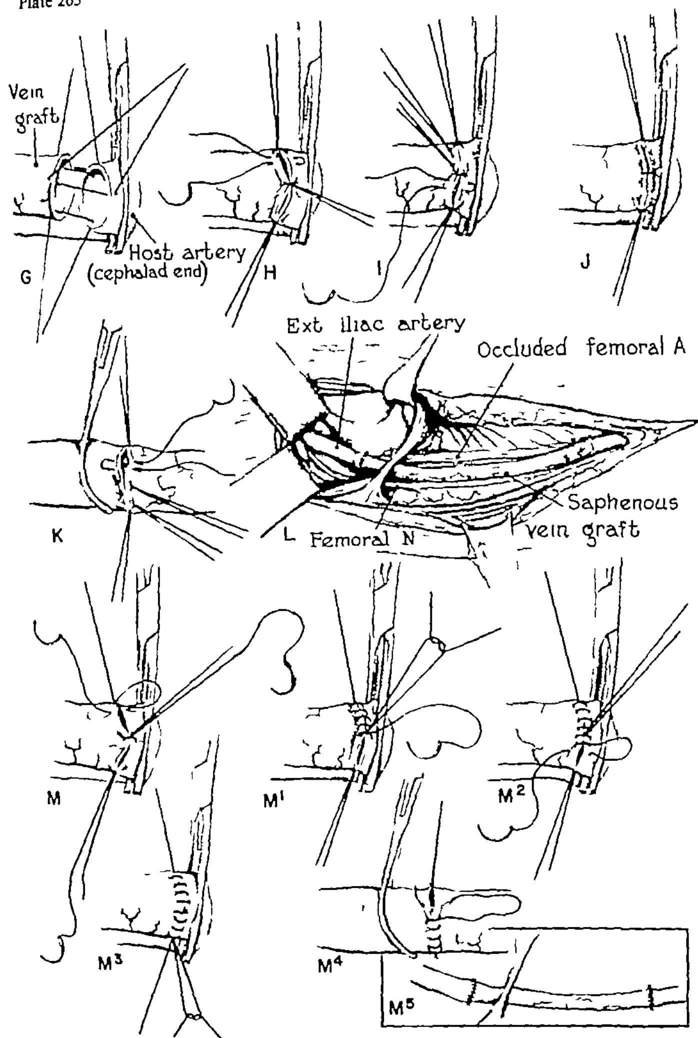


G, H, I, J, K. These are close-up views to show the details of the anastomosis. The free end of the vein graft is turned upward, and the three cardinal guy sutures are inserted but not tied (G). One of the guy sutures is inserted in the midline posteriorly and each of the remaining two are inserted at either lateral angle (G). The cardinal guy sutures are tied (H), and the ends of the vessels are approximated posteriorly with everting mattress sutures of 00000 silk swedged on minimum trauma needles (H, I, J). The free end of the vein graft is then turned downward, and, in like manner, the anterior layer of the anastomosis is being completed (K).

L. The insertion of the autogenous vein (saphenous) graft is completed, and its relation to the occluded segment of the femoral artery and to the inguinal ligament are demonstrable.

M, M^1, M^2, M^3, M^4, M^5. These close up views demonstrate an alternate method of performing a blood vessel anastomosis by the use of a continuous over and over suture of arterial (00000) silk. The suture is started posteriorly (M) with the needle strand of one of the lateral guy sutures and is continued to the midline where it is tied to the free strand of the posterior guy suture (M). The needle strand of this suture is continued (M^2) toward the opposing lateral guy suture and tied to its free strand (M^3). The vein graft is then turned downward, and the needle strand of the second lateral guy suture is continued anteriorly toward the opposing lateral angle suture (M^4) where the anastomosis was originally started. The completion of the insertion of the vein graft using a simple over and over suture is shown (M). This particular technic, the more desirable, is a simple, rapid, and effective method of anastomosis.

Plate 265



Vein graft
Host artery (cephalad end)
G
H
I
J
Ext iliac artery
Occluded femoral A
K
L
Femoral N
Saphenous vein graft
M
M1
M2
M3
M4
M5

N N¹ N² N³ N⁴ N⁵ The technic of performing the anastomosis illustrated is the same as that previously described (M M M³ M M⁴) with the exception that a continuous everting mattress rather than an over and over suture is employed. This technic, included for completeness, is the least desirable

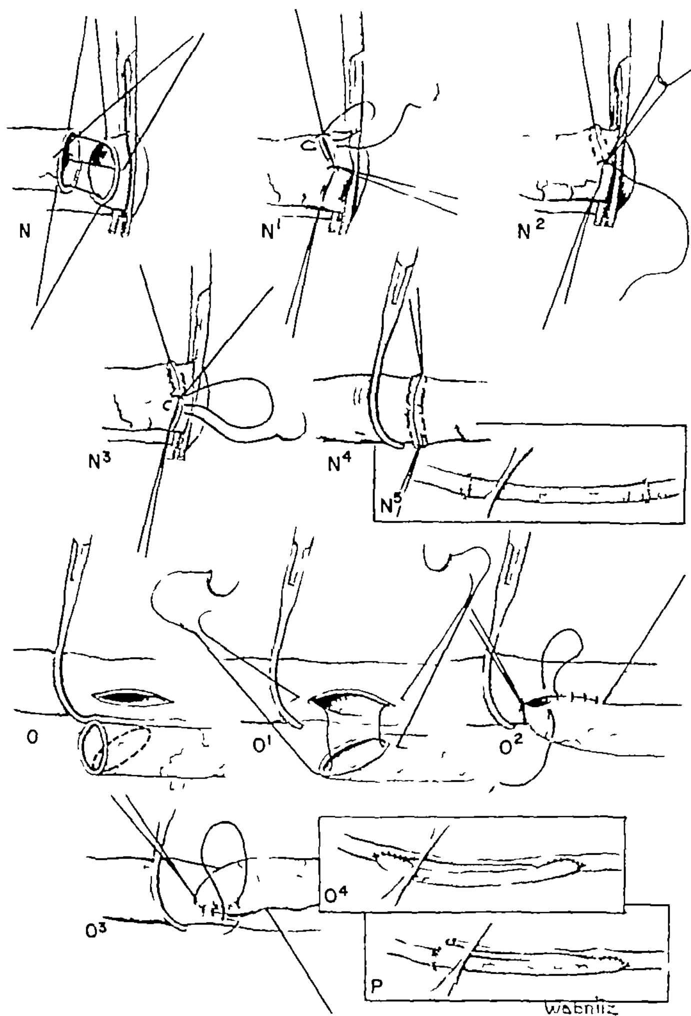
O O¹ O² O³ O⁴ These illustrations depict the technic for the performance of an end-to-side bypass of an occluded arterial segment. The artery cephalad is cross-clamped and, just below the clamp a lateral opening is made into the arterial lumen (O). The end of the vein graft is cut on a bias (dotted outline) to obtain a flat approximation to the side of the artery (O) The angle guy sutures (00000 silk) are inserted but not tied (O¹). The needle strand of the lower guy suture is inserted from below upward as an over and over suture toward the upper angle guy suture (O²), where it is tied to its free end.

The needle strand of the upper angle guy suture is then inserted on the opposite side from above downward as an over and over suture toward its starting point at the lower angle (O³), where it is tied to the free strand of the lower angle guy suture The inset (O⁴) shows the completion of the end to-side bypass shunt utilizing an autogenous vein (long saphenous) graft.

P This inset shows a modified bypass shunt in which an end-to-end anastomosis is performed cephalad and an end to-side anastomosis caudad This method was used in one patient in whom a thrombus formed in the lumen of an end to-side bypass shunt vein within 8 to 10 minutes after its insertion. The cephalad end of the anastomosis was disconnected, the thrombus evacuated, and the lumen of the vein was irrigated with heparin–saline solution. The reanastomosis cephalad was performed end to-end rather than end to-side, with a satisfactory result.

In the restoration of continuity in the lower iliac and femoral arteries either by resection and graft or a shunt bypass, the use of an autogenous vein (long saphenous) as illustrated (A to L), rather than an arterial homograft or cloth prosthesis, is preferred. The illustrations (A to L) depicting the insertion of the autogenous vein graft were from sketches made at the time of operation upon a 65-year-old man. This patient was admitted to the hospital because of severe pain secondary to an ischemic ulcer (4 by 3 cm.) of two years duration overlying the anterior aspect of the midportion of the right leg A lumbar sympathetic ganglionectomy performed 18 months previously had no beneficial effect. In fact, because of the severity of the pain, the patient requested that the leg be amputated. Following the insertion of the vein graft as depicted (A to L), pulsations in the dorsalis pedis and posterior tibial arteries were restored. Post operatively the relief of pain was immediate, and the ulceration of the leg healed completely in 11 days. At the end of a follow-up period of two and one-half years, the patient was still asymptomatic and the peripheral arterial pulsations were easily palpable.

DISCUSSION—DR. JOHN P WEST With experience and skill, a surgeon can expect to restore circulation about an occluded femoral artery with the various technics so clearly shown in these drawings. The recorded experience to date indicates that a higher percentage of good results are obtained by end-to-side anastomosis as shown in Plate 2660⁴ The anastomotic orifices need to be wide and better results follow the use of large caliber grafts. When well supported by muscle an autogenous vein graft may be the ideal ar ... substitute. However the removal of the v ... the operative trauma, and at times the ... vein is not of caliber Further expe... ded to determine the relative merits of ... arteries and ostheses.


N
N1
N2
N3
N4
N5
O
O1
O2
O3
O4
P
Wabnitz

THROMBOENDARTERECTOMY

A. The incision overlying the femoral triangle (solid line) and its subsequent extension caudad (dotted line) are indicated If desired separate cephalad and caudad incisions may be employed However in the experience of the author the single long incision has proved the more satisfactory It is not associated with an increase in the operative morbidity and the objection to the length of the incision based on cosmetic reasoning is believed not of practical significance

B C. The femoral artery is incised (B), and, after the insertion of guy sutures of silk (00000) in either incised margin, the underlying thrombus is mobilized with a dissecting instrument of special design* (C) In making the incision in the artery (B), the thinness of its wall overlying the thrombus should be emphasized. Otherwise the thrombus itself may be incised and the improper cleavage plane entered. Characteristically the inner lining of the wall of the artery surrounding the thrombus has a glistening sheen which is indicative of the proper plane for dissection.

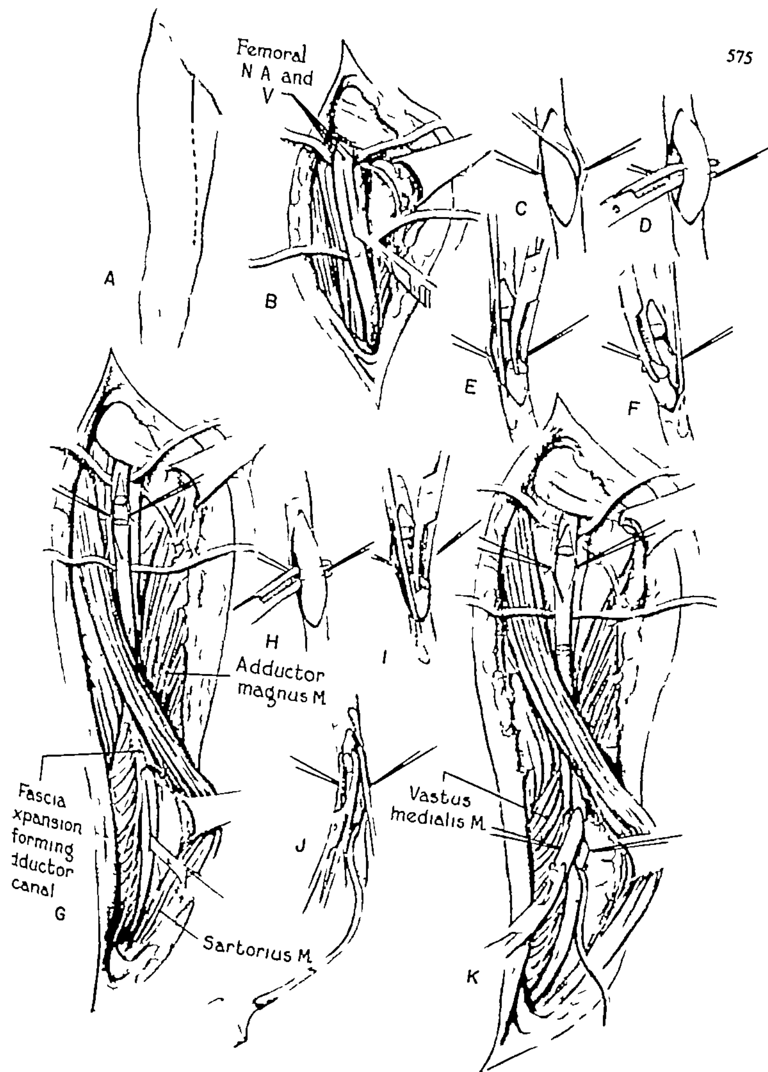
*Manufactured by Edward Weck & Co., Brooklyn, New York

D The mobilized portion of the thrombus, which occludes the lumen of the femoral artery is elevated on a clamp (Mixter), and a small segment is excised (dotted line).

E, F The transected end of the caudad portion of the thrombus is secured in a curved clamp and, with the use of the dissecting instrument, the thrombus is separated from the arterial wall.

G H I. In like manner a second separate incision is made in the lower portion of the femoral artery within Hunter's canal (G), and the underlying thrombus is mobilized (H I) as previously described If need be, three rather than two femoral arteriotomies may be made.

J, K. A catheter (No 14 F) is inserted into the lumen of the femoral artery distally and through it a solution of heparin (100 mg. of heparin in 250 ml. of normal saline) is intermittently instilled (J). Through the lower femoral arteriotomy the thrombus is mobilized cephalad (J) to the level of the completed dissection previously made in a caudad direction through the upper femoral arteriotomy and the intervening thrombotic segment is withdrawn (K).


Femoral
N A and
V
A
B
C
D
E
F
Adductor
magnus M
H
I
J
Fascia
xpansion
forming
dductor
canal
G
Sartorius M
Vastus
medialis M
K

L. The lower arteriotomy is closed with a continuous suture of *00000* arterial silk swedged on a minimum trauma needle Similarly the caudad portion of the upper arteriotomy is closed, and the dissection of the cephalad portion of the thrombus within the femoral artery is begun A catheter (No 14 F) through which a solution of heparin is intermittently instilled, is inserted within the cleared lumen of the femoral artery distally

M, N O The dissection of the thrombus is continued (M), and, when it is completed, bleeding is controlled by gentle digital compression (N) A kidney stone-grasping forceps is inserted cephalad in the lumen of the femoral artery to remove any remaining thrombotic debris (N) Upon completion of the thromboendarterectomy bleeding is controlled by digital compression rather than clamp occlusion of the femoral artery cephalad as the closure of the upper arteriotomy is being completed (O) In this patient, a 74-year-old man, an excellent pulsation throughout the whole length of the femoral artery was restored.

P Q. In patients in whom the femoral arterial pulsations are present, and the popliteal, dorsalis pedis, and posterior tibial pulsations are absent, *exploration of the* femoral artery in Hunter's canal is performed. The patient is placed in the lateral recumbent position, and the lower extremity that is uppermost is supported on pillows (P). The linear incision overlying Hunter's canal (solid line) and its subsequent S-shaped extension (dotted line) to expose the popliteal artery are depicted (P). Upon exploration of the femoral artery in Hunter's canal (Q), adequate arterial pulsations were present. Accordingly an S-shaped extension, depicted by the dotted line (Q), was made for exposure of the popliteal artery

DISCUSSION—DR. JOHN P WEST The illustrated technic of thromboendarterectomy is a most satisfactory one. *However it has been our experience* that, in general, attempts to clear the lumen of long segments of small vessels, such as the superficial femoral and popliteal arteries, are often unsuccessful. The incidence of prompt recurrent occlusion has been high. For this reason, we favor a bypass operation when a good and patent artery can be found at either end of the obstruction. The ideal case for thromboendarterectomy is one in which there is a *short segmental occlusion. Such obstructions* are often found at the bifurcation of the common femoral artery In some cases, removal of a segment of thrombus facilitates the insertion of a graft, and, in such cases, a judicious combination of thrombectomy and grafting is likely to give the best result.

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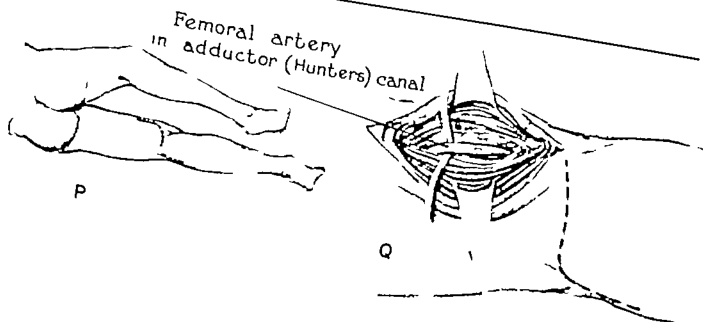
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Great saphenous V
Adductor magnus M
Sartorius M.
M
Catheter
N
L
Saphenous N
O
Vastus medialis M



R. The S-shaped incision in the popliteal space is completed, the flaps are mobilized, and the incision in the posterior crural fascia is shown in dotted outline

S. The incision in the posterior crural fascia is completed, and the neurovascular contents of the popliteal fossa are exposed.

T The tibial nerve is encircled by a guy suture of silk (00) and retracted to show the subjacent popliteal vein and artery The branch of the tibial nerve which bifurcates before its entrance into the medial head of the gastrocnemius muscle is shown. Similarly the collateral tributary and branch of the popliteal vein and artery respectively are depicted Although an excellent pulsation in the collateral arterial vessel was present, the lumen of the popliteal artery immediately caudad was occluded with a thrombus.

U V W X, Y The incision in the popliteal artery and the mobilization of the thrombus is the same as previously described (B C, D E, F) Similarly heparin solution is instilled intermittently through a catheter (No 12 F) into the cleared lumen of the popliteal artery caudad as the thrombus *is being dissected cephalad* (X). Upon completion of the removal of the thrombus, bleeding is controlled by proximal digital compression as the arteriotomy is closed, using a continuous over and over suture of 00000 arterial silk swedged on a minimum trauma needle In this patient, a 53 year-old man with a serpiginous ulceration overlying the lateral aspect and lower third of the left leg, an excellent pulsation was restored in the popliteal artery

Z. Inset to show the completion of the closure of the S-shaped incision in the popliteal fossa.

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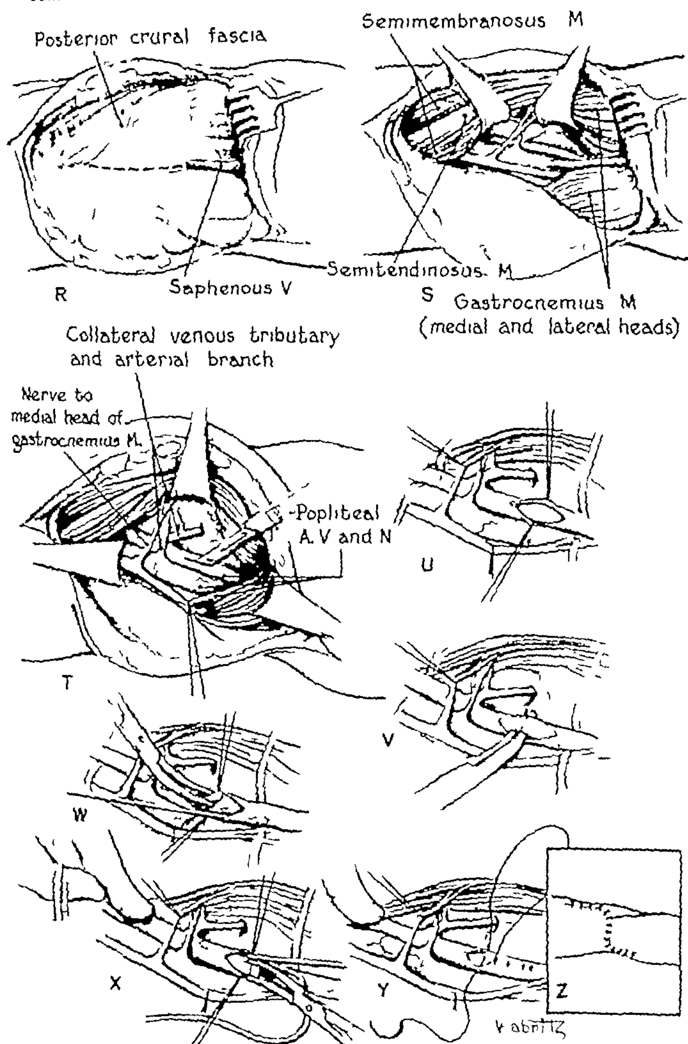
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Posterior crural fascia
Semimembranosus M
Saphenous V
Semitendinosus M
R
S
Gastrocnemius M
(medial and lateral heads)
Collateral venous tributary
and arterial branch
Nerve to
medial head of
gastrocnemius M.
-Popliteal
A. V and N
U
T
V
W
X
Y
Z
Kabritz

A. The patient is placed in the supine position with the left side of the thorax slightly elevated. The anterolateral incision employed is indicated by the curvilinear dotted line

B. The incised margins of the pericardium are retracted by guy sutures of silk (000) to expose the anterior descending branch of the left coronary artery This artery partially mobilized, is encircled by two silk (No 1) sutures, between which the incision in the artery (dotted line) is subsequently made. The use of the encircling sutures in combination with finger compression for hemostasis is preferred to clamp (serrefine) occlusion.

B[1] This is a sketch of the instrument of special design used for the dissection and mobilization of the thrombus.

C. The incision in the artery is completed, and the underlying thrombus which occludes its lumen is exposed. Four sutures of silk (00000) are inserted through either incised margin of the artery and will be used for later closure of the incision after completion of the coronary thromboendarterectomy

D. The free ends of the four sutures previously inserted are separated into two groups, upper and lower and grasped in clamps. The respective loops formed by the sutures are held in hook retractors and retracted cephalad and caudad respectively A segment of the occluding thrombus is separated from the arterial wall and elevated on the dissecting instrument. The dotted lines indicate the segment of the thrombus to be resected.

E. A segment of the thrombus is resected, and the transected end caudad is grasped in a clamp for traction as dissection of this portion of the thrombus is being performed.

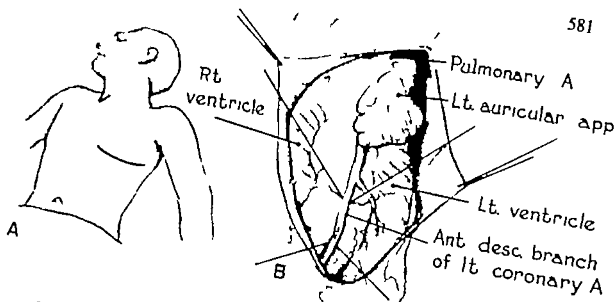
F Following the removal of the caudad segment of the thrombus, free retrograde bleeding occurred. Similarly the transected end cephalad is grasped in a clamp for traction as dissection of this segment of the thrombus is being performed. The thrombus was easily separated from the adjacent wall of the artery the lining of which was characterized by a healthy glistening sheen. This finding, in conjunction with the ease with which the thromboendarterectomy was performed, is believed indicative of the technical feasibility of the operation.

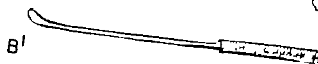
F[1], G. Upon completion of the removal of the thrombus cephalad, a No 6 ureteral catheter was inserted into the lumen of the coronary artery and through its orifice into the lumen of the aorta. As the catheter was slowly withdrawn, 10 ml. of a heparin-saline solution (100 mg. of heparin in 250 ml. of saline) was injected. When the withdrawal of the catheter was completed, a forceful ejection of blood through the coronary arteriotomy which reached the level of the skin drapes, was observed. Hemostasis was obtained by digital compression overlying the arteriotomy preparatory to approximation of the incised margins of the artery by traction upon the sutures previously inserted (G) As traction is maintained, the sutures are tied individually (G) to complete the closure of the coronary arteriotomy One additional suture was subsequently required. The use of this particular technic obviates the necessity for clamp occlusion of the coronary artery following the reestablishment of its blood flow This is considered a desirable technical aid in the prevention of stasis thrombosis.

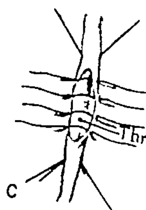
Manufactured by Edward Weck & Co., Brooklyn, New York

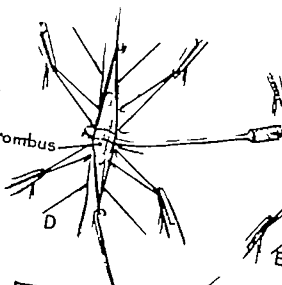
The patient, a 47 year-old man, was admitted to the hospital on February 10, 1957 because of severe angina on effort and resulting marked physical incapacitation. A previous history of a coronary occlusion in 1949 and again in 1952, as well as a bout of congestive failure in July of 1955 was obtained. Because of the severity of the symptoms and the limitation of physical activity operation was advised and performed on February 21 1957 Upon exposure of the heart, extensive atherosclerotic occlusive disease of both coronary arteries was present. Although initially a cardiopericardiopexy was conte it was decided to attempt a coronary thr rectomy which was performed as illu after entrance into the left pleural c of the heart occurred which responde

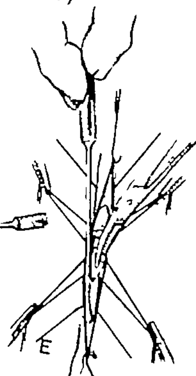
to manual massage. Stoppage for the second time occurred before completion of the thromboendarterectomy and again responded to m massage.
Postope immediate the pa-
tient was th the e a per
sistent hy in thre the
operation, tly a a cup
of black nk How-
ever seve tive pe-
ripheral va rr
died one a t
half hours
postoperativ
was complet
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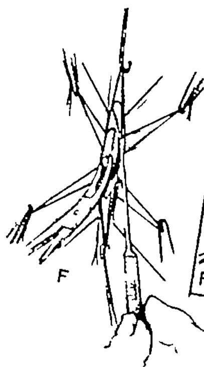

A
Rt ventricle
Pulmonary A
Lt. auricular app
Lt. ventricle
Ant desc. branch of lt coronary A
B

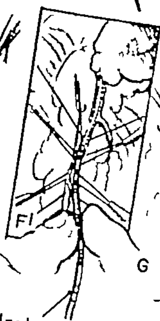

B'

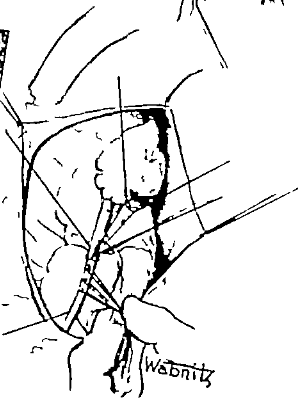

C


Thrombus
D


E


F


F1


G
Ureteral (Nº6) catheter
Wabnitz

solution of neoprene latex type 571 was injected (with the heart in situ) in a retrograde manner into the ascending aorta which was cross-clamped immediately distal to the site of injection. The heart and the occluded segment of the ascending aorta were removed, and, 24 hours later, dissection of the coronary arteries was performed. It was of interest to observe that the left coronary artery and its anterior descending branch and related collateral vessels were filled with red-colored neoprene latex. Contrariwise, the circumflex branch of the left coronary artery and the right coronary artery which were not operated upon, were occluded by atherosclerotic thrombi. Through the center of each of these thrombi, a faint red line of the latex dye indicative of the size of the lumen within the thrombus was discernible. The result of this study was considered positive evidence of the continued patency of the left coronary artery and its anterior descending branch for the duration of the short period (eight-and-one half hours) of survival of the patient following the coronary thromboendarterectomy

The objection that the coronary arteries are too small to maintain the patency of the lumen when reestablished may prove more of a theoretical than a practical objection. Certainly the central head of arterial pressure within the aorta in relation to the orifices of the coronary arteries is much greater than the head of pressure in relation to the orifices of peripheral arteries of similar diameter Accordingly it is believed a fallacy to negate the potential value of coronary thromboendarterectomy based on the poor results obtained in the performance of thromboendarterectomy in vessels of similar size in the peripheral arterial tree. Furthermore, despite the finding of extensive coronary atherosclerosis, as was present in this patient, the restoration of blood flow in one coronary vessel segment may prove beneficial. It is only by further cumulative experience that the practical value of coronary thromboendarterectomy will be either proved or disproved. Certainly the findings at operation in this particular patient proved that coronary thromboendarterectomy was technically a feasible operation. Following completion of the thromboendarterectomy it was indeed most impressive to observe the force with which the blood was ejected and the volume of flow through the coronary arteriotomy with each systolic contraction of the ventricles.

Supplied through the courtesy of E I du Pont de Nemours & Co Elastomer Chemicals Department, New York City

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DISCUSSION—DR. CLAUDE S. BECK. The problem of coronary thromboendarterectomy is not so simple as it appears on the surface. It is scarcely comparable to cleaning out debris from other arteries. If you put a string on the descending ramus of the left coronary artery and keep it there for a half hour or so and then release the artery the probability is that the heart will fibrillate as red blood enters this ischemic muscle. This was a worry to me for many years because I and my associates in the laboratory always considered arterial blood to be good for the heart and never bad. Here we had an indication that arterial blood could kill the heartbeat. Finally the explanation became clear If you anesthetize a dog and then clamp off the intratracheal tube for six to nine minutes, the dog becomes cyanotic and the heart becomes cyanotic. If you take a cotton electrode moistened with sodium chloride solution and sweep it across the ventricles, the electrogram is precisely the same as that obtained from a uniformly well-oxygenated heart. What does this mean? It means that the amount of oxygenated blood delivered to the heart has a relationship to the electrical condition, the electrical equilibrium, or electrical stability of the heart. A blue baby has a stable heart. If you put a string on a coronary artery you create a blue or cyanosed area of muscle in a pink or well-oxygenated heart. If you cannulate a coronary artery in a blue or asphyxiated heart and perfuse arterial blood into this artery you create a pink area of muscle in a blue heart. Both of these hearts are electrically unstable and may fibrillate. The S–T segment of the electrogram is elevated over the blue area and depressed over the pink area. Pink or well-oxygenated muscle in juxtaposition with blue or cyanosed muscle creates an electrical condition that can fibrillate the heart A baby with one coronary artery coming off the aorta and the other coming off the pulmonary artery has anginal pain and dies. This electrical situation is created because of differences in oxygen content or as we have called them, oxygen differentials. It is not the amount of blood that kills it is an uneven or checkerboard distribution of oxygen that kills. When the physiologist tied off a coronary artery and lifted electrical reactions from the heart, he called them currents of injury " This concept is wrong. Creating pink and blue muscle in juxtaposition has nothing to do with "injury " This condition kills hundreds of thousands of men and women in this country every year These are the people who die on the golf course, watching an exciting athletic contest, in the office, and so on. They are examples of self-electrocution of the heart. This often occurs in hearts that are too good anatomically to "die," and it often occurs without an infarct.

It is possible, therefore, to fibrillate the heart when one coronary artery is opened for a free flow of arterial blood and when the other two arteries are severely stenosed. Under certain conditions, red blood can kill the heartbeat

This statement does not imply that there are no instances when the opening of an artery would not be beneficial to the heart. The writer has had numerous experiences in which the introduction of red blood would have been beneficial to the heart—cases in which the descending area of muscle would not contract because of inflow reduction. On many occasions, attempts were made to clean out the diseased artery without success. The disease was in the arterial wall, and to remove it would have required removal of the entire wall of the artery The writer has operated upon 500 human beings for coronary artery disease. Almost always, the disease is in the primary secondary and tertiary branches of the coronary arteries—much too widespread for removal. Localized disease is rarely found.

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Coronary Thromboendarterectomy

Discussion—Dr. William P. Longmire, Jr. With the assistance of Dr. Albert Kattus of the Department of Medicine in the selection and preparation of patients, Dr. Jack A. Cannon and I have operated upon five patients for severe incapacitating angina pectoris without evidence of myocardial infarction by the technic of direct vision coronary thromboendarterectomy. Four of these patients survived the operative procedure. Over a short period of time, all seemed to have been improved. Improvement was noted, not only on the basis of subjective criteria, but also on the objective evidence of improved myocardial circulation: this evidence was obtained from electrocardiographic tracings taken during exercise both before and after operation. Operations designed to improve myocardial circulation and relieve symptoms of angina pectoris are notoriously difficult to appraise, and this procedure must await further evaluation before its true efficacy and future status can be estimated. The early results are encouraging.

The operative procedure, as described by Dr. Madden and also used by us in five patients, has proven that it is technically feasible to perform thromboendarterectomy of the major coronary vessels of the heart. Our limited experience has also demonstrated that it is possible to select patients for operation in whom the occlusive disease is limited to the major coronary vessels—i.e., vessels which may be attacked by direct surgical procedures. The crucial question to be answered by further observation pertains to the continued patency of these small vessels after thromboendarterectomy has been performed. The observation, as reported here by Dr. Madden, that patency of the thromboendarterectomized vessel could be demonstrated some eight-and-one half hours after operation, supports the belief that the coronary arteries will remain patent following this procedure.

In the procedure we have used, the patient is placed in the supine position, the thorax is entered through a bilateral thoracotomy incision made at the fourth interspace, and the sternum is divided. The pericardium is opened widely and all major coronary vessels are inspected and palpated. With this approach it is possible to open both the right main coronary artery and the left anterior descending artery. This incision is not suitable for an approach to the left circumflex artery. After the condition of the major vessels is evaluated, the smaller branches of the coronary arterial system are appraised by inspection and palpation. In only one case was there found to be slight beading of the smaller branches of the coronary arterial system. This was not felt to be sufficient reason, however, to occlude these smaller branches. The epicardial fat is dissected away from the major coronary vessels. In two cases, both the right main coronary artery and the left anterior descending artery were thromboendarterectomized, in two cases, only the right main coronary was so treated, and in one case, the left anterior descending artery alone was operated upon. As the epicardial fat is stripped away from the major vessels, the areas of disease inside the lumen of the vessel may be identified, owing to the marked adherence of the epicardial fat to the vessel at such a point.

In operations upon the right main coronary artery the vessel is exposed from its origin at the base of the aorta for a distance of approximately 3.5 to 4 cm., at which point it breaks up into its terminal branches. The left anterior descending artery is exposed from its origin at the left circumflex artery peripherally until it also branches into several smaller vessels. After this artery is widely exposed, a ligature is passed about the vessel at its origin and again peripherally or about the major peripheral branches. A test period of complete occlusion of the vessel is then conducted by placing a "bulldog" clamp across the vessel for a period of six minutes. During this time, the color of the myocardium supplied by this branch is observed, as well as the rate and rhythm of the heart. The heart action is monitored by the electrocardiogram. We have not attempted to open any vessel if the heart did not tolerate complete occlusion of the vessel for a period of six minutes without showing any signs of regional cyanosis or arrhythmia.

A longitudinal incision is made in the vessel over the area which, by palpation, shows the most advanced disease, and the thickened intimal core is separated from the surrounding media and adventitia. It is not difficult to establish a good plane of cleavage between the structures and to isolate the obstructing core. Ligatures are then placed about the core at the proximal and distal ends of this incision. An elevator similar to that described in Dr. Madden's article, but modified so as to permit the instrument to be adjusted to different angles, is used to elevate the core from the media and adventitia of the vessel. If necessary additional longitudinal incisions are made in the vessel at the site of the major branches so that the branching core can be removed from these smaller vessels. When the limits of dissection with the elevator are reached, a circular stripper is inserted over the core and passed down the vessel between the core on one side and the media and adventitia on the other. The stripper is carried as far distally as possible: usually when the thickened intima thins out and is freed from the surrounding layers of the vessel, it divides readily and is removed from the vessel intact. A similar procedure is then repeated in the proximal end of the vessel. In the case of the right coronary, the core is stripped up into the sinus of Valsalva at the mouth of the coronary artery. In the case of the left anterior descending coronary, the dissection is continued proximally into the lumen of the left circumflex artery. In all cases, a vigorous pulsatile flow has been established from the proximal end of the vessel, and abundant back bleeding from the distal end of the vessel has been obtained. A catheter has been inserted in the lumen of the coronary for the injection of heparin solution, as described by Dr. Madden, but in more recent cases a small amount of powdered heparin was placed directly into the lumen of the vessel following thromboendarterectomy.

The longitudinal incisions in the vessel are closed with continuous 000000 arterial silk sutures, the epicardial fat is resutured over the isolated artery, and the pericardium is closed loosely with interrupted sutures of silk. Two catheters are placed in both pleural spaces, and the thoracotomy incision is closed in layers in the usual fashion.

The one fatality in this series occurred in a 53-year old, white, male patient, who was operated upon for severe incapacitating angina pectoris. In this case, an uneventful endarterectomy of the right main coronary artery was performed. During the subsequent removal of the thickened intima from the left anterior descending artery, sudden irreversible dilation and asystole of the heart occurred. Again, it should be stressed that this procedure is currently in the stage of evaluation, and its true place in the surgeon's armamentarium has not been clearly established.

References (see page 642)

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The operative procedure, as described by Dr Madden and also used by us in five patients, has proven that it is technically feasible to perform thromboendarterectomy of the major coronary vessels of the heart. Our limited experience has also demonstrated that it is possible to select patients for operation in whom the occlusive disease is limited to the major coronary vessels—i e., vessels which may be attacked by direct surgical procedures. The crucial question to be answered by further observation pertains to the continued patency of these small vessels after thromboendarterectomy has been performed. The observation, as reported here by Dr Madden, that patency of the thromboendarterectomized vessel could be demonstrated some eight and-one half hours after operation, supports the belief that the coronary arteries will remain patent following this procedure

In the procedure we have used, the patient is placed in the supine position, the thorax is entered through a bilateral thoracotomy incision made at the fourth interspace, and the sternum is divided The pericardium is opened widely and all major coronary vessels are inspected and palpated. With this approach it is possible to open both the right main coronary artery and the left anterior descending artery This incision is not suitable for an approach to the left circumflex artery After the condition of the major vessels is evaluated, the smaller branches of the coronary arterial system are appraised by inspection and palpation. In only one case was there found to be slight "beading" of the smaller branches of the coronary arterial system. This was not felt to be sufficient reason, however to occlude these smaller branches. The epicardial fat is dissected away from the major coronary vessels. In two cases, both the right main coronary artery and the left anterior descending artery were thromboendarterectomized, in two cases, only the right main coronary was so treated and in one case the left anterior descending artery alone was operated upon. As the epicardial fat is stripped away from the major vessels, the areas of disease inside the lumen of the vessel may be identified, owing to the marked adherence of the epicardial fat to the vessel at such a point

In operations upon the right main coronary artery the vessel is exposed from its origin at the base of the aorta for a distance of approximately 3.5 to 4 cm at which point it breaks up into its terminal branches. The left anterior descending artery is exposed from its origin at the left circumflex artery peripherally until it also branches into several smaller vessels. After this artery is widely exposed, a ligature is passed about the vessel at its origin and again peripherally or about the major peripheral branches. A test period of complete occlusion of the vessel is then conducted by placing a "bulldog" clamp across the vessel for a period of six minutes. During this time, the color of the myocardium supplied by this branch is observed, as well as the rate and rhythm of the heart. The heart action is monitored by the electrocardiogram. We have not attempted to open any vessel if the heart did not tolerate complete occlusion of the vessel for a period of six minutes without showing any signs of regional cyanosis or arrhythmia.

A longitudinal incision is made in the vessel over the area which, by palpation, shows the most advanced disease, and the thickened intimal core is separated from the surrounding media and adventitia. It is not difficult to establish a good plane of cleavage between the structures and to isolate the obstructing core. Ligatures are then placed about the core at the proximal and distal ends of this incision. An elevator similar to that described in Dr Madden s article, but modified so as to permit the instrument to be adjusted to different angles, is used to elevate the core from the media and adventitia of the vessel. If necessary additional longitudinal incisions are made in the vessel at the site of the major branches so that the branching core can be removed from these smaller vessels. When the limits of dissection with the elevator are reached, a circular stripper is inserted over the core and passed down the vessel between the core on one side and the media and adventitia on the other The stripper is carried as far distally as possible usually when the thickened intima thins out and is freed from the surrounding layers of the vessel, it divides readily and is removed from the vessel intact. A similar procedure is then repeated in the proximal end of the vessel. In the case of the right coronary the core is stripped up into the sinus of Valsalva at the mouth of the coronary artery In the case of the left anterior descending coronary the dissection is continued proximally into the lumen of the left circumflex artery In all cases, a vigorous pulsatile flow has been established from the proximal end of the vessel, and abundant back bleeding from the distal end of the vessel has been obtained. A catheter has been inserted in the lumen of the coronary for the injection of heparin solution, as described by Dr Madden, but in more recent cases a small amount of powdered heparin was placed directly into the lumen of the vessel following thromboendarterectomy

The longitudinal incisions in the vessel are closed with continuous 000000 arterial silk sutures, the epicardial fat is resutured over the isolated artery and the pericardium is closed loosely with interrupted sutures of silk. Two catheters are placed in both pleural spaces, and the thoracotomy incision is closed in layers in the usual fashion.

The one fatality in this series occurred in a 53-year old, white, male patient, who was operated upon for severe incapacitating angina pectoris. In this case, an uneventful endarterectomy of the right main coronary artery was performed. During the subsequent removal of the thickened intima from the left anterior descending artery sudden irreversible dilation and asystole of the heart occurred Again, it should be stressed that this procedure is currently in the stage of evaluation, and its true place in the surgeon s armamentarium has not been clearly established

REFERENCES (see page 642)

LIGATION OF THE SUPERFICIAL FEMORAL VEIN

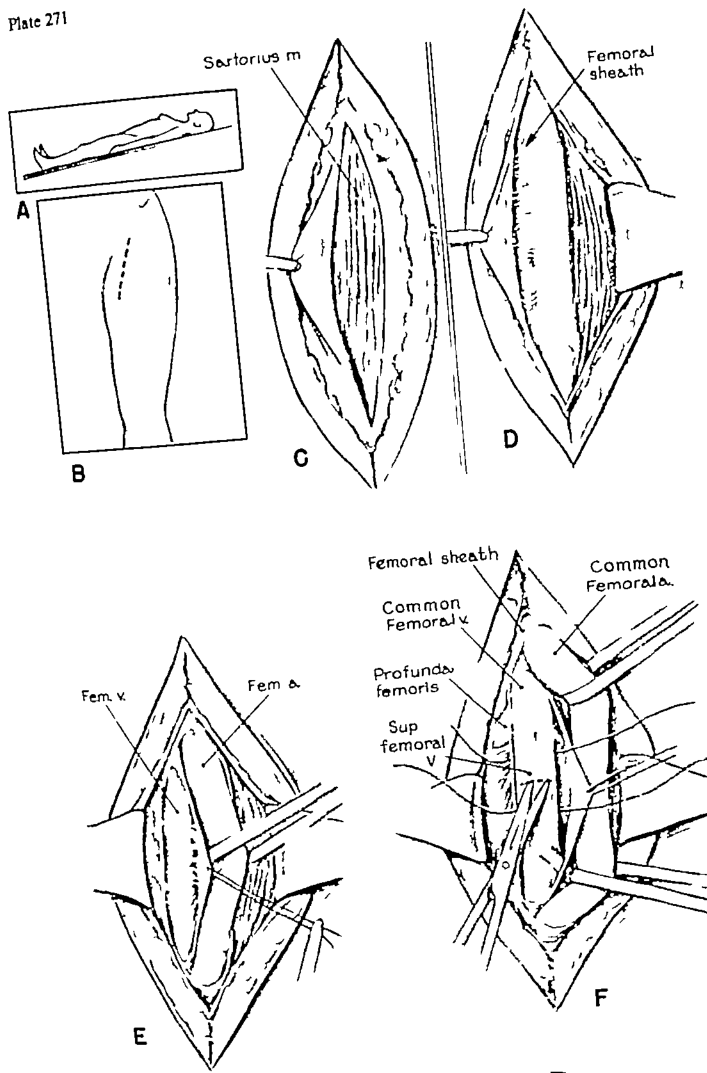
A, B. The patient is placed in a 10- to 15-degree semi Fowler's position (A). The site of the incision in the upper third of the thigh overlying Scarpa's triangle is indicated in dotted outline (B).

C, D. The incision is deepened through the underlying subcutaneous fat and deep fascia (C) to expose the medial border of the sartorius muscle, which is retracted laterally to demonstrate the proximal portion of the femoral sheath and the enclosed femoral artery and vein (D). The characteristic anatomic feature of the common femoral sheath is that the encased vessels are each enclosed by their own respective sheaths, which are demonstrable in the succeeding illustrations (E, F)

E. The common femoral sheath is opened, *and the mobilized portion of the femoral* artery is encircled with a cotton tape and retracted laterally The separate sheath encasing the femoral vein is incised, and the lateral cut margin is secured in a guy suture (000 silk) for traction preparatory to the mobilization of the underlying femoral vein.

F The femoral artery is encircled by two cotton tapes and retracted laterally In this regard, caution must be observed to avoid excessive tension and angulation of the artery because of the danger of producing arterial spasm and secondary stasis thrombosis. In fact, the traction force and angulation of the artery depicted in the illustration is unwarranted and should not be practiced. The superficial femoral vein is mobilized and partially encircled by two ligatures of silk (00). The dotted line between the ligatures indicates the site of the opening to be made in the anterior wall of the vein by scissor dissection The clot within the lumen of the vein is depicted by the dark shadow extending cephalad to the level of entrance of the profunda femoris tributary

Plate 271



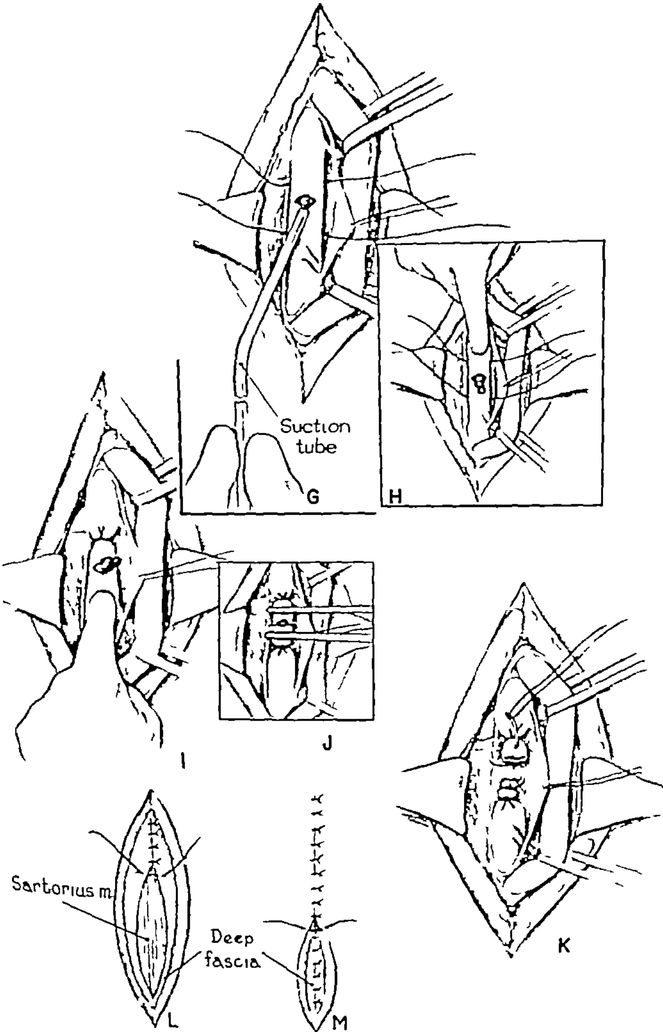
Sartorius m
Femoral sheath
A
B
C
D
Fem. v.
Fem a.
E
Femoral sheath
Common Femoral a.
Common Femoral v.
Profunda femoris
Sup femoral V
F

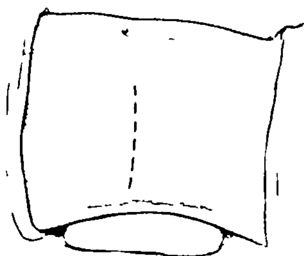
G The incision in the superficial femoral vein is completed, and the partially extruded clot is being aspirated by suction.

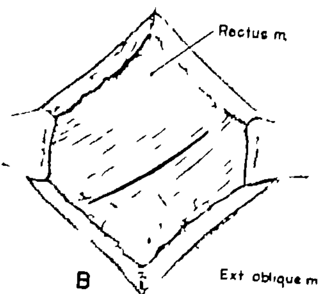
H, I, J By digital retrograde "milking," more of the clot is extruded through the phlebotomy site (H), and, when the cephalad evacuation of the clot is completed, the upper encircling ligature of silk (00) is tied (I). Similarly by digital "milking," the clot, caudad in the lumen of the vessel is evacuated (I), and the lower encircling ligature is tied (J). The superficial femoral vein is doubly clamped between the ligatures, and the transection of the vein at the site of the phlebotomy is completed as indicated by the dotted line (J).

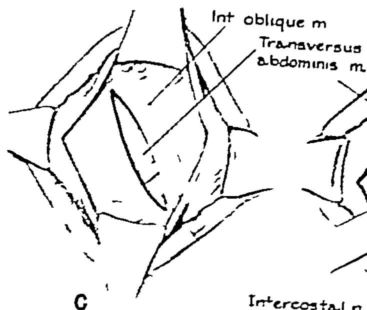
K. The distal transected end of the superficial femoral vein is further occluded with a suture ligature of silk (000) and its proximal transected end is being similarly occluded. For clarity the clamp has been removed from the proximal transected end as the suture ligature is being inserted.

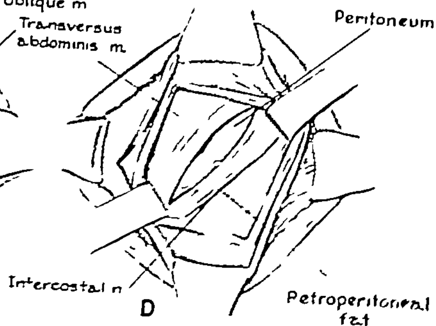
L, M. The deep fascia (L) and skin (M) are closed with interrupted sutures of 000 silk to complete the operation.

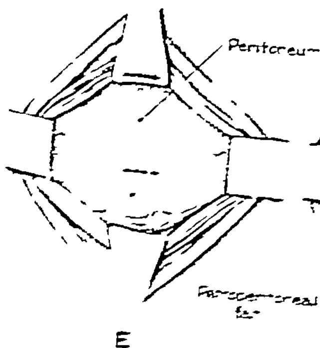

Suction tube
G
H
I
J
K
Sartorius m
Deep fascia
L
M

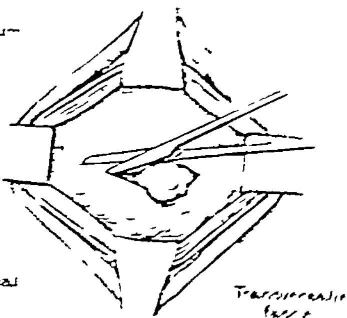

A


Rectus m
B
Ext oblique m


Int oblique m
Transversus abdominis m
C


Peritoneum
Intercostal n
D
Retroperitoneal fat


E


F

LIGATION OF THE INFERIOR VENA CAVA

A. The patient is placed in the supine position, and the right side is elevated to approximately a 25 degree angle from the horizontal. The incision extends transversely from the lateral border of the rectus muscle at the level of the umbilicus outward to the midaxillary line just beneath the costal margin, as indicated in dotted outline.

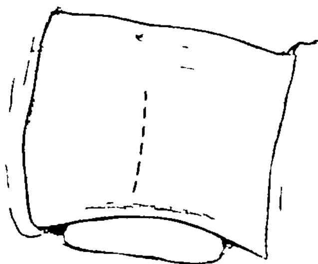
B. The upper and lower skin flaps are dissected immediately beneath the subcutaneous tissue plane and retracted to expose a large surface area of the external oblique muscle and the line of separation of its fibers. A portion of the rectus sheath is also visible.

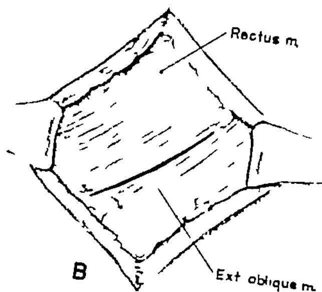
C. The separated margins of the external oblique muscle are retracted to expose the fibers of the internal oblique which is the thickest of the three muscles to be separated. Through the line of separation of the fibers of the internal oblique the underlying transversus abdominis muscle and one of the intercostal nerves are visible.

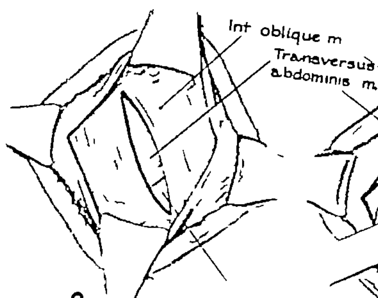
D The transversus abdominis muscle is separated in the direction of its fibers, and the irregular line of apposition of the retroperitoneal fat with the peritoneum is visible. The dissection of this muscle, the thinnest of the group is begun laterally and continued medially to lessen the possibility of opening into the peritoneal cavity

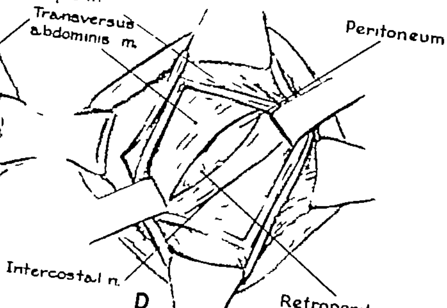
E. The muscles of the anterolateral abdominal wall are separated, and the line of apposition of the retroperitoneal fat and peritoneum may now be clearly seen. The dotted line indicates the site of incision in the transversalis fascia overlying the retroperitoneal fat.

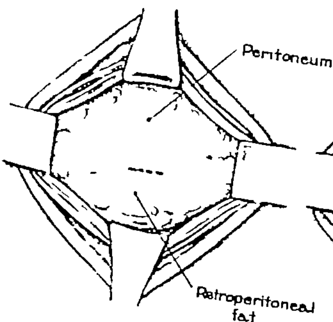
F The transversalis fascia is incised by scissor dissection, and a portion of the retroperitoneal fat is seen to herniate through the opening.

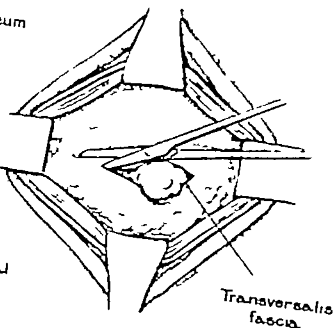

A


Rectus m.
Ext oblique m.
B


Int oblique m
Transversus abdominis m.
C


Peritoneum
Intercostal n.
Retroperitoneal fat
D


Peritoneum
Retroperitoneal fat
E


Transversalis fascia
F

G H. By blunt digital dissection in the retroperitoneal fatty tissue plane, the peritoneum and the intraperitoneal viscera adjacent are displaced toward the midline. During this dissection, an important landmark is the psoas major muscle which is located more anteriorly than one generally assumes. The tissue dissection is continued anterior and medial to this muscle other wise troublesome technical difficulties may ensue. When the dissection is completed to the vertebral column, blunt digital dissection is continued first cephalad and then caudad in the same plane A wide type Harrington retractor is used to maintain retraction of the peritoneum and the encased adjacent viscera. The right ureter is then identified as it courses along in the fatty tissue plane on the anterior surface of the inferior vena cava.

I. The right ureter is retracted from the anterior surface of the vena cava, and the line of incision in the overlying fibroareolar tissue layer (fascia of Gerota) is depicted.

J The inferior vena cava is exposed preliminary to the completion of the mobilization of its circumference at the level selected for ligation. In the isolation and mobilization of the inferior vena cava, a medium sized "kidney pedicle" clamp and a malleable ligature carrier* with a ball-point protected tip are the instruments that have proved the most useful Medially the vena cava is in timately adherent to the adjacent tissues, and the lumbar veins enter posteromedially Accordingly during the dissection and mobilization posteriorly and medially one must be careful to avoid either an avulsion tear of one of the lumbar veins or an in advertent perforation of the vena cava. Should either occur bleeding is best con trolled by immediate compression of the vena cava with "stick" sponges both prox imal and distal to the site of hemorrhage. Hemostasis may then be obtained by closure of the opening with sutures of fine silk (00000) swedged on a minimum trauma needle.

K L. The mobilized segment of the vena cava is encircled with two ligatures of braided silk (No 1), using a malleable ligature carrier and a double ligation in continuity is performed.

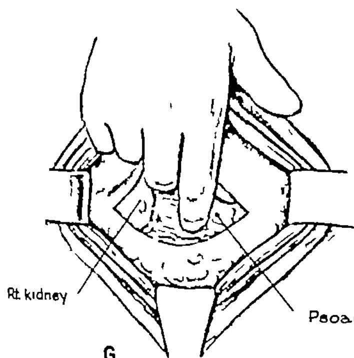
*Manufactured by Edward Weck & Co Inc., Brook lyn, N Y

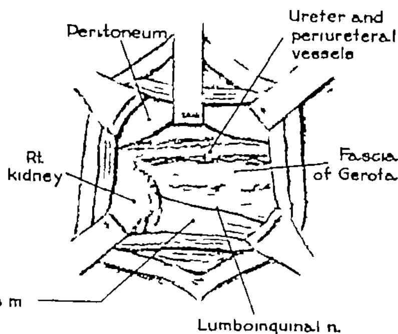
DISCUSSION—DR. JERE W LORD During the decade from January 1 1948, through December 31 1957 on the surgical services of the Fourth Division, Belle vue Hospital, the University Hospital, and in this commentator's private practice only two patients were subjected to ligation of the inferior vena cava. The vast majority of the patients with thromboemboli were treated with anticoagulants. In fact, only 10 patients were operated upon. In six of these, ligation of the superficial femoral vein was performed. In two of the remaining four one had a ligation of the superficial femoral vein and the other had a ligation of the right common iliac vein. In the remaining two, ligation of the inferior vena cava was done. At operation, when palpation revealed thrombotic material, the vein was opened, aspirated both prox imally and distally and then doubly ligated in con tinuity

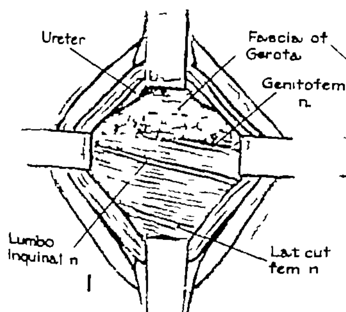
Although the author's personal experience has been most favorable with ligation of the inferior vena cava, several papers in the literature have emphasized the serious late sequelae of ulceration, edema, and recurrent phlebitis. We have observed these complications in three patients in whom ligation of the inferior vena cava was performed on the Fourth Surgical Division of Bellevue Hospital be tween 1944 and 1948.

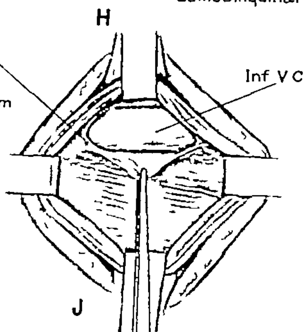
In the postoperative management of the patient following ligation of the superficial femoral vein or ligation of the inferior vena cava, the important fac tors which should be stressed are (1) the wearing of custom-made elastic stockings for prolonged periods to control the edema of the legs (2) elevation of the foot of the bed on blocks (10 inches) and (3) the adherence to strict hygienic measures in the care of the feet to avoid a fungus infection. In some patients the wearing of an elastic support may be discontinued within six to eight months, whereas, in others, it may be necessary to continue the use of elastic supports for the remainder of their lives.

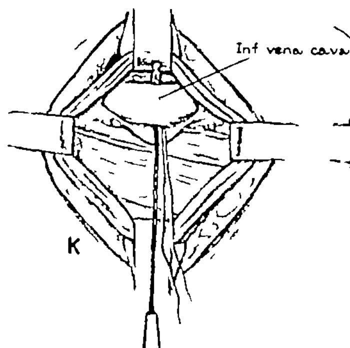
In regard to surgical technic, the artist's illustrations are clear and the accompanying text is entirely adequate. The use of "stick" sponges for the control of bleeding from torn lumbar veins is considered the best method for hemostasis. The sponges are held in place for 8 to 10 minutes to allow the for mation of a blood clot to block the bleeding point. The venous pressure in the inferior vena cava is usually low and may be lowered still further by depressing the head of the table (Trendelenburg position). Clamps should rarely be applied to the vena cava. If bleeding persists, it should be controlled either by the use of silver (dural or Cushing) clips or transfixion sutures of fine silk (00000) swedged on a minimum trauma needle.

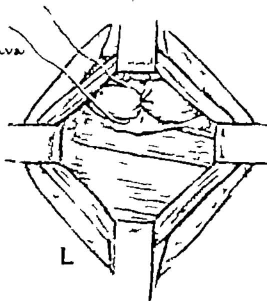

Rt. kidney
Psoas m
G


Peritoneum
Ureter and periureteral vessels
Rt. kidney
Fascia of Gerota
Lumboinguinal n.
H


Ureter
Fascia of Gerota
Genitofem n.
Lumbo inguinal n
Lat cut fem n
I


Inf V C
J


Inf vena cava
K


L

M. The operative field after completion of the double ligation in continuity of the inferior vena cava is shown.

N O P Q These illustrations depict the technic that is employed when a thrombotic occlusion of the lumen of the inferior vena cava, commonly associated with phlegmasia cerulea dolens, is present. The vena cava is incised between the encircling but untied ligatures of silk (No 1) and the thrombus is evacuated (O). This is done by digital compression, first from above downward until free retrograde bleeding from the renal veins occurs. The proximal ligature is then tied (P) The thrombus is next evacuated from below upward, and the distal ligature is tied (P) If desired, an additional suture of the transfixion type may be inserted between the ligatures as indicated (Q)

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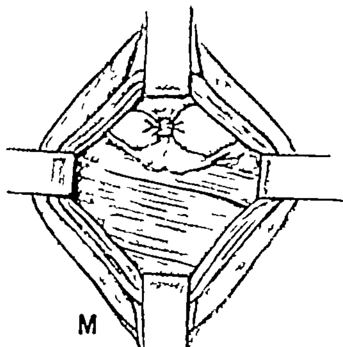
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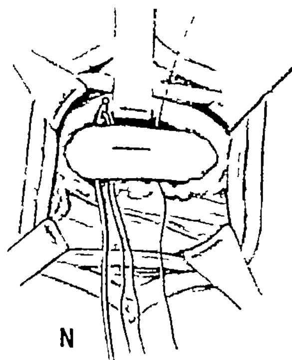
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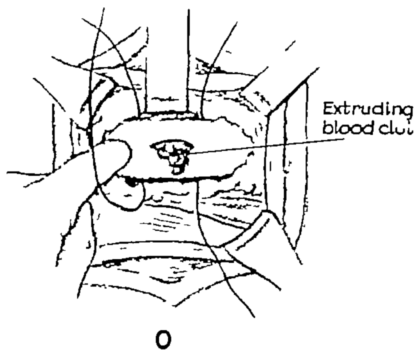
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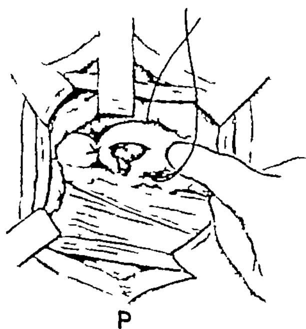
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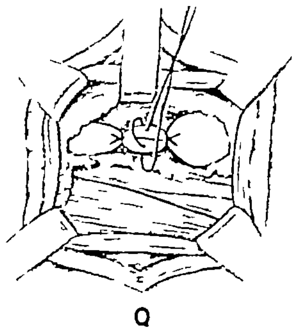
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M


N


Extruding
O


P


Q

R S. These illustrations depict an alternate but less desirable method of transection of the vena cava This is done between clamps following double ligation in continuity The severed ends are occluded with transfixion sutures of silk as the clamps are removed.

T The retractors in the retroperitoneal tissue plane have been removed, and the overlying muscle layers of the anterolateral abdominal wall tend to approximate themselves. The line of apposition of the retroperitoneal fat and peritoneum is visible beneath the incompletely approximated fibers of the transversus abdominis muscle. The adjacent intercostal nerve may also be seen.

U V W The closure of the remainder of the muscle layers and the skin, using interrupted sutures of silk (000), is depicted.

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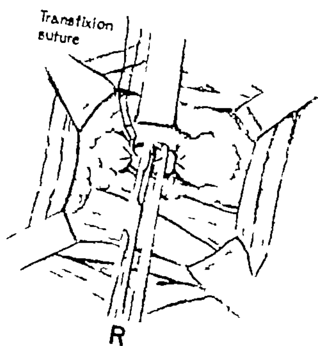
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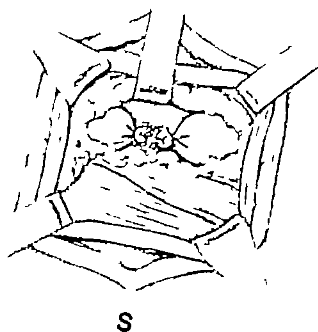
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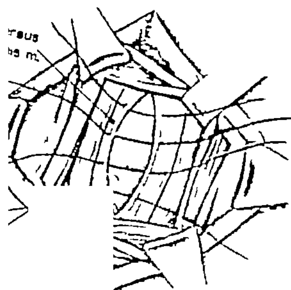
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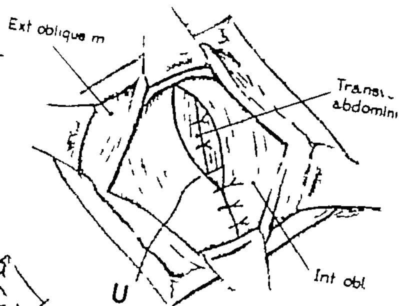
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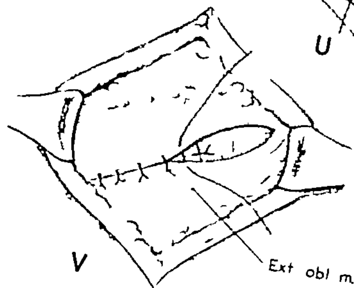
Plate 276

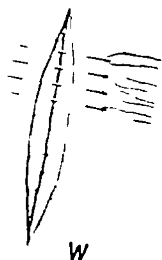












SPLENECTOMY AND END-TO-SIDE SPLENORENAL SHUNT

A. The patient is placed in the supine position, and the left side is elevated on a pillow support to approximately a 30 degree angle from the horizontal. The incisions of choice, a long curvilinear subcostal incision solid line) that extends from the left costophrenic angle to the posterior axillary line, and an abdominothoracic incision (dotted outline) that enters the left pleural cavity through the eighth interspace, are shown. In this particular patient, the subcostal incision was used.

B C. The incision is deepened through the rectus sheath, the underlying fibers of the rectus abdominis, the external oblique, and the internal oblique muscles to expose the transversus abdominis muscle and its aponeurosis.

D The peritoneal cavity is entered, and the relation of the enlarged spleen to the surrounding structures is depicted. An opening is made in an avascular segment of the gastrocolic ligament preliminary to the serial clamping and severance of its proximal extension, the anterior layer of the gastrosplenic ligament.

E. The mobilization of the spleen is continued by doubly clamping and cutting (dotted line) the anterior layer of the gastrosplenic ligament and its contained vasa brevia.

F The superior border of the pancreas is exposed, and the splenic artery is encircled by a ligature of silk (00) for traction as mobilization of the artery is completed by scissor dissection. A second ligature of silk (00) is subsequently inserted, and double ligation, in continuity of the splenic artery is performed.

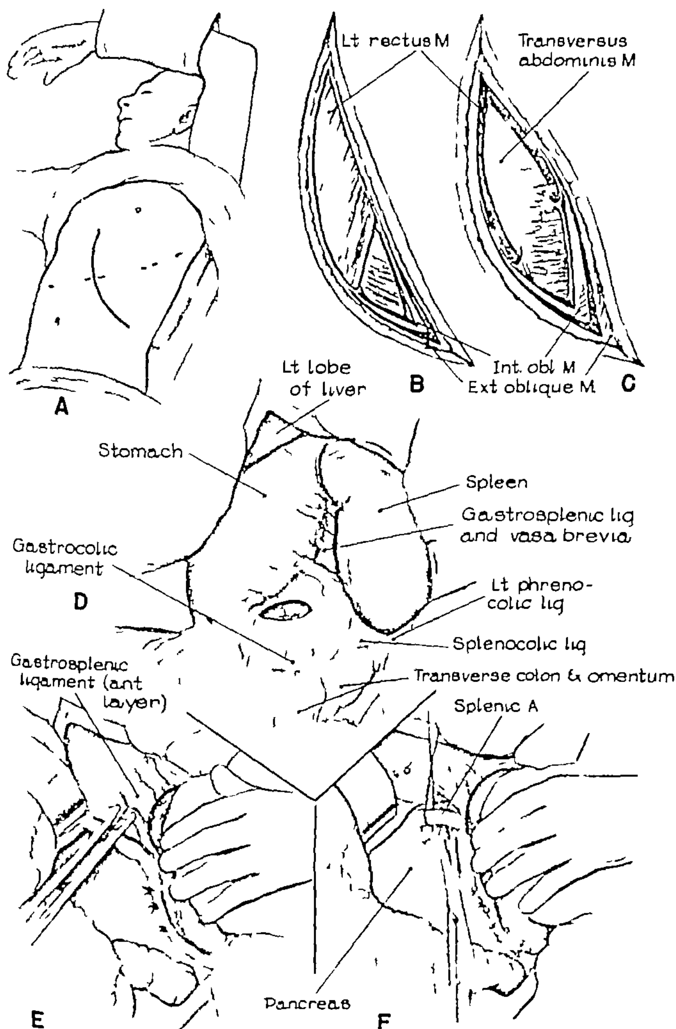
DISCUSSION—DR. LOUIS M ROUSSELOT Portasystemic shunts are primarily indicated for the relief of gastroesophageal hemorrhage by lowering the portal tension in the syndrome of portal hypertension. The commentator's preference is a direct end to-side portacaval shunt rather than a splenorenal shunt. It is my opinion that a splenorenal shunt should be reserved for those cases in which the former is not feasible, i e an extrahepatic portal vein block, either congenital or acquired.

The incisions illustrated in Plate 277A represent standard approaches. The combined thoracoabdominal incision (dotted line) gives the optimal exposure With the combined approach, the abdominal component should be initially opened to confirm the diagnosis and establish operability An unsuspected hepatoma or a secondary malignant disease that obstructs the portal bed may be established, a biopsy taken, and the operation terminated forthwith

In the presence of inflammatory pulmonary disease, the incision should be limited to the abdomen. Besides the subcostal incision shown in Plate 277A, a long transverse incision from the midline well out to the flank may be substituted.

The operative steps in the Plates 277 through 280 are clearly illustrated with exactitude. Certain admonitions and variations are presented. Rarely should blunt dissection be attempted in any operation for portal hypertension. The relatively avascular organ attachments found in other disease states are not present in portal hypertension. Extensive collateralization is regularly found in the splenocolic ligament (D), the gastrosplenic ligament (E), and the lienorenal ligament (O). Furthermore, highly vascular adhesions usually envelop the spleen and fix it to the diaphragm and the lateral parietal peritoneum. These should be serially clamped, severed, and ligated. Blunt dissection is extremely hazardous and may be accompanied by severe blood loss (O).

The illustrations D through J represent the expo-



Lt rectus M
Transversus abdominis M
Int. obl M
Ext oblique M
A
B
C
Lt lobe of liver
Stomach
Spleen
Gastrosplenic lig and vasa brevia
Gastrocolic ligament
D
Lt phreno-colic lig
Splenocolic lig
Transverse colon & omentum
Gastrosplenic ligament (ant layer)
Splenic A
Pancreas
E
F

G The spleen is manually rotated and displaced toward the midline and the reflection of the posterior parietal peritoneum forming the posterior layer of the lienorenal ligament is severed under direct vision by scissor dissection. Normally this ligament is avascular However in the presence of portal hypertension, the application of clamps to this ligament is frequently required to prevent excessive blood loss from the extensive collateral vascular bed.

H. The spleen is reposited laterally and the superior segment of the gastrocolic ligament is doubly clamped and severed (dotted line) This segment is the narrowest portion of the gastrosplenic ligament, and particular care should be observed in the application of clamps to prevent injury to the greater curvature of the stomach. Furthermore, one of the largest of the vasa brevia is contained in this narrow uppermost portion of the gastrosplenic ligament in relation to the superior pole of the spleen. Accordingly in the mobilization of the superior pole of the spleen, one should proceed with caution to avoid an avulsion laceration of this vessel and resulting hemorrhage.

I. Following the completion of the severance of the anterior layer of the gastrosplenic ligament, the spleen is again rotated toward the midline, and the pad of vascular areolar tissue, in relation to the inferior pole of the spleen and the tail of the pancreas, is doubly clamped prior to its severance.

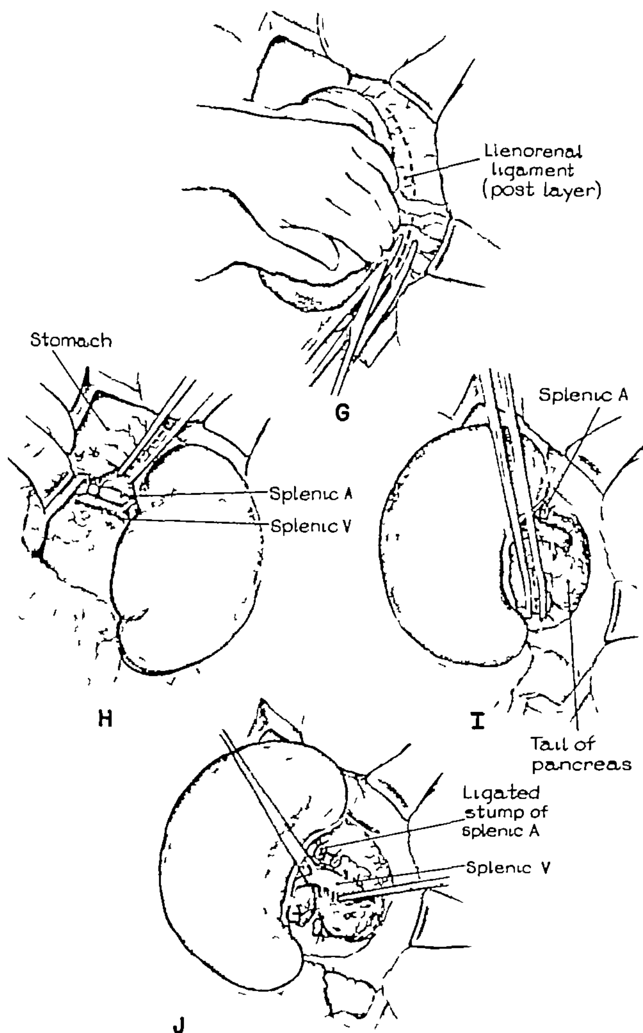
J The splenic vein in the hilum of the spleen is encircled with a traction ligature of silk (00), and the vein is mobilized by clamping and dividing the pancreatic tributary veins as indicated.

Discussion—Dr. Rousselot (cont.)

sure of the true pedicle from its lateral and posterior aspects. An alternate method is to expose the pedicle from its anterior surface, medial to the splenic hilum The steps depicted in D through H are followed as shown. At this juncture, several moist laparotomy pads are inserted into the splenic bed in the subphrenic space, and the spleen is displaced downward and forward The arterial ligation is completed as shown in H However the mobilization of the splenic vein proceeds from the anterior surface of the pedicle as in H, rather than rotating the spleen and continuing the dissection as demonstrated in I, J and K.

Upon completion of the exposure of the pedicle of the left kidney the commentator finds it desirable to identify early the ureter and tab it with cotton tape in a manner similar to that in which the renal vein is tabbed in M Occasionally limitations of exposure make the use of short, spring type, "bulldog" clamps preferable to the long handle Potts ductus clamps shown in K. Individual preference may again call for a modification in technic. The Glover auricular clamp or Satinsky type clamp is in my opinion a more versatile instrument than the Potts–Smith clamp used by the author (N). A greater surface area of the renal vein may be occluded, which permits the surgeon a wider clearance between the edge of the new stoma and the margin of the occlusive clamp. Cutting an oval opening in the side wall of the renal vein rather than making a linear incised wound as indicated (N) is again an alternative step This facilitates the suture anastomoses and minimizes late stenosis or closure of the stoma site.

In the illustrations O through S, several modifications are permissible. Instead of using interrupted sutures in the anterior layer (Q) a continuous suture like that shown for the posterior layer (O) may be used. In children, interrupted sutures are probably preferable for both the posterior and the anterior layers to compensate for the increase in the size of the vessels during growth and, accordingly prevent decrease in size of the stoma. Instead of the everting type of sutures depicted (O Q), a continuous noneverting suture, interrupted only at the angles of the anastomosis, may be used both anteriorly and posteriorly Furthermore, if desired, additional stay sutures may be inserted at each angle prior to the insertion of the continuous sutures forming the anterior and posterior layers of the anastomosis.


Lienorenal ligament (post layer)
G
Stomach
Splenic A
Splenic V
H
Splenic A
I
Tail of pancreas
Ligated stump of splenic A
Splenic V
J

K. The mobilized segment of the splenic vein is doubly clamped using both angulated and straight Potts ductus clamps. The site for transection of the vein, in juxtaposition to its bifurcation at the hilum of the spleen, is indicated by dotted lines. The incision in the anterior layer of the renal fascia for the exposure and subsequent mobilization of *the kidney is also indicated in dotted out* line

L. The left kidney is mobilized from its surrounding adipose capsule and rotated toward the midline. The relation of the kidney to the left adrenal gland and the surrounding structures is visible.

M. The mobilized kidney is rotated laterally and posteriorly and the distal segments of the renal artery and vein are mobilized by a combination of blunt and sharp dissection. The renal vein is encircled by cotton traction tapes to facilitate its manipulation.

N The lumen of the renal vein is partially occluded by a Potts-Smith clamp, and the proximal cut end of the splenic vein is turned down toward the incised opening in the renal vein preparatory to the anastomosis.

DISCUSSION—DRS. ARTHUR H BLAKEMORE AND ARTHUR B VOORHEES, JR. The position of the patient on the operating table, the location and technic of the incision are similar to those described in *Portal vein-to-vena cava anastomosis*, with the exception that all takes place on the left rather than the right side of the patient (Fig. 1).

When the operative incision and general abdominal examination have been completed, manometric pressures in the portal system are recorded by the described technic. A liver biopsy is obtained in the described fashion however in this case it is usually obtained from the left lobe rather than the right lobe of the liver

At this point the operation can be divided into three steps for sake of convenience of description. The first step is the mobilization and subsequent resection of the spleen. The second step is the identification and mobilization of the splenic vein, and the third step is the performance of an end-to-side anastomosis between the splenic vein and the left renal vein.

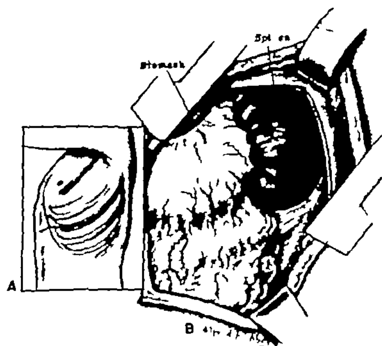
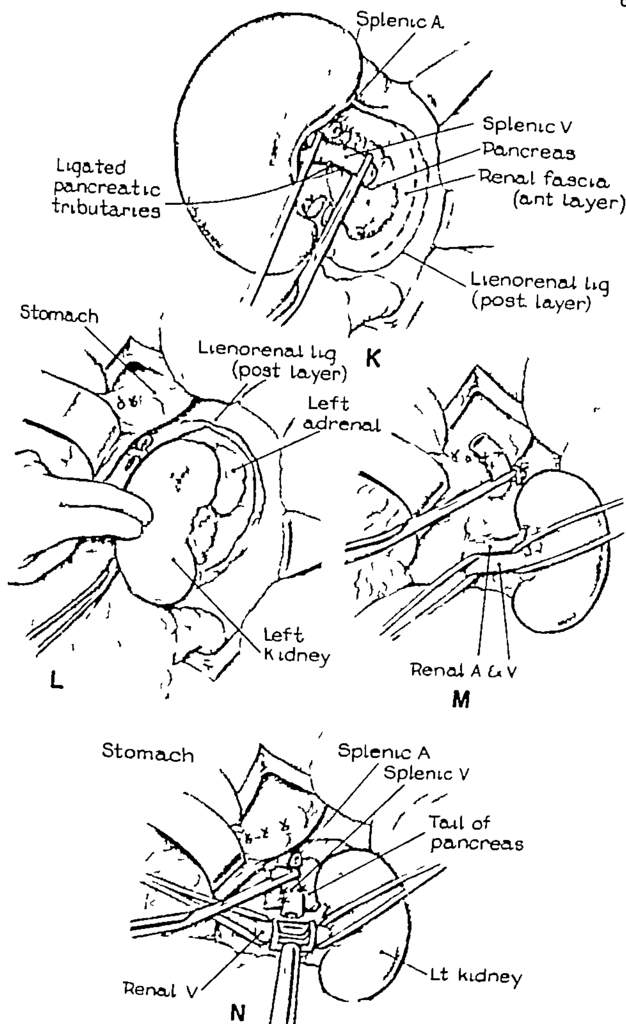


Fig 1 A, line of incision, B, Illustrating exposure following completion of a thoracoabdominal approach. Note that splitting the diaphragm affords direct access to control of hemorrhage in separating an adherent spleen from the diaphragm


Splenic A
Splenic V
Pancreas
Renal fascia (ant layer)
Ligated pancreatic tributaries
Lienorenal lig (post layer)
K
Stomach
Lienorenal lig (post layer)
Left adrenal
Left kidney
L
Renal A & V
M
Stomach
Splenic A
Splenic V
Tail of pancreas
Renal V
Lt kidney
N

O P Q R. Close-up illustrations to show more clearly the technic of the anastomosis of the proximal cut end of the splenic vein to the longitudinal opening in the side of the left renal vein.

O P The posterior suture layer is inserted This is a continuous eversion suture of 00000 arterial silk on a swedged-on minimum trauma needle. The suture is commenced from the "outside in" on the splenic vein and terminates from the "inside out" on the same vein Between its commencement and termination, the suture is inserted alternately from the "inside out" to the "outside in" on the renal and splenic veins respectively Accordingly the loop is on the outside of the lumen, and, when the suture is drawn taut, it causes an eversion of the tissues with intima to intima approximation.

Q The anterior layer of the anastomosis consists of a series of interrupted everting mattress sutures of silk (00000). These sutures are all inserted, and the end sutures are tied. One of the strands of each of the end mattress sutures is then tied to either end of the continuous everting posterior suture (a–a).

R. The completed anterior layer of the anastomosis prior to the release of the Potts-Smith clamp is shown.

S. The completed end to-side splenorenal shunt and its relation to the surrounding structures is illustrated.

Discussion—Drs. Blakemore and Voorhees (cont.)

Step 1 (Figs. 2 and 3). The gastrolienal and lienocolic ligaments are divided. The anterior rim of the spleen is rotated laterally in order to expose the hilar structures. The splenic artery is identified and doubly ligated proximal to its subdivision. The splenic vein is identified and gradually mobilized by sharp dissection to the hilus of the spleen. A rubbershod noncrushing clamp is applied as the splenic vein goes beneath the tail of the pancreas, and a crushing clamp is applied to the splenic vein as it emerges from the hilum. The vein is transected, and the spleen is removed after division of its diaphragmatic attachments.

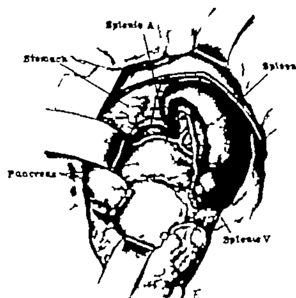


Fig 2 Exposure of short gastric vessels, splenic artery and splenic vein

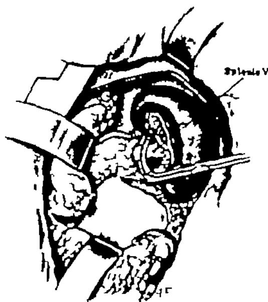
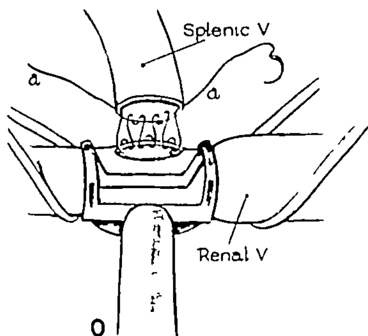
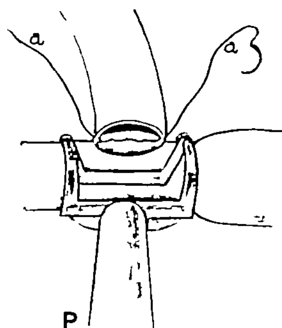


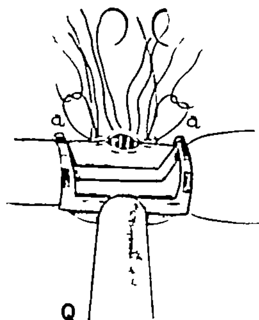
Fig. 3 A rubbershod clamp has been placed on the splenic vein, and it is ready for section well distal to the clamp



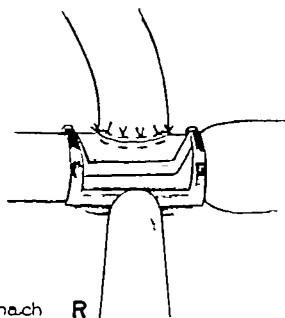
Splenic V
a
a
Renal V
O



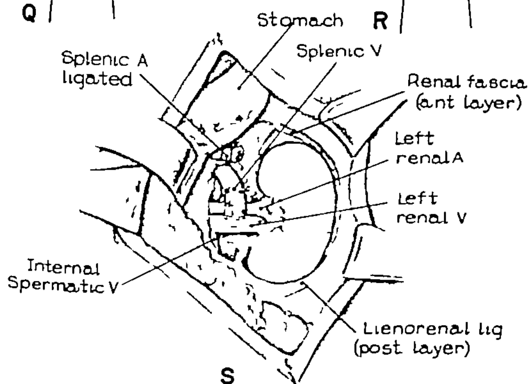
a
a
P



a
a
Q



R



Stomach
Splenic A ligated
Splenic V
Renal fascia (ant layer)
Left renal A
Left renal V
Internal Spermatic V
Lienorenal lig (post layer)
S

DISCUSSION—DRS. BLAKEMORE AND VOORHEES (cont.)

Step 2 (Figs. 4 and 5). The noncrushing rubber shod clamp compressing the stump of the splenic vein is released for an instant to allow a rush of venous blood through the splenic vein stump to carry away any clot which may have formed in the splenic vein during the course of the splenectomy Following this, the rubbershod clamp is reapplied, and 20 ml. of a dilute heparin–saline solution are injected into the splenic vein stump proximal to the point of compression by the clamp The vein is retracted forward, and a usually incomplete collar of pancreatic tissue is divided between clamps along the posterior aspect of the splenic vein stump. Following the division of this areolar and pancreatic tissue for a distance of approximately 3 cm. parallel to the posterior aspect of the splenic vein stump, the tail of the pancreas is drawn forward, and the splenic vein is drawn laterally The splenic vein is gradually dissected free from the overlying tail of the pancreas. During this last maneuver it is exceedingly important to identify and to transfix with 00000 braided arterial silk the numerous, tenuous, venous tributaries entering the splenic vein from the tail of the pancreas. If these veins are placed under too much traction, they will tear at their juncture with the splenic vein, and the subsequent repair of the tear in the splenic vein will compromise the lumen and subsequently jeopardize the efficiency of the shunt. The mobilization of the splenic vein stump is carried medially to the point where the inferior mesenteric vein joins the splenic vein.

Step 3 (Fig. 6). The peritoneum overlying the left kidney is incised over the hilus of the kidney This initial line of incision is bisected by a similar peritoneal incision running parallel to the left renal vein. The renal vein is gradually mobilized over a distance of approximately 3 cm. midway between the hilus of the kidney and the vena cava. Two major venous

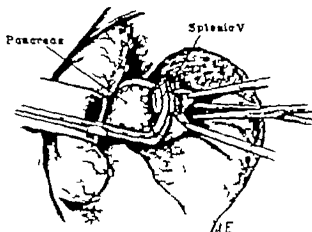


Fig 4. Illustrates beginning mobilization of splenic vein.

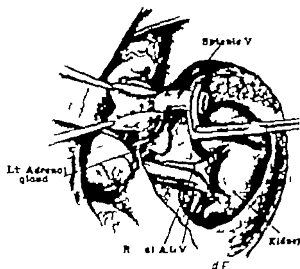


Fig 5 Displays the mobilized stump of the splenic vein. Note the tunnel between the left adrenal gland and the upper pole of the left kidney the result of removing retroperitoneal fat.

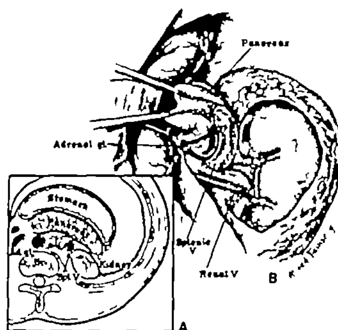


Fig. 6. B, an illustration of the completed splenorenal shunt Note in cross-section illustration A that the splenic vein rests in a deep sulcus between the left adrenal gland and the upper pole of the kidney out of harm's way from compression by the pancreas

Discussion—Drs. Blakemore and Voorhees (cont.)

tributaries, the left spermatic (or ovarian) vein and the adrenal vein, should be identified and preserved where possible. However if the preservation hampers subsequent anastomosis, both may be ligated with impunity After clearing the renal vein, the left adrenal gland and its vascular supply are identified, and the adrenal gland is pushed medially by dividing its adventitial attachment to the kidney capsule By pushing the adrenal gland medially a sulcus can be developed between the adrenal gland and the upper pole of the left kidney which will subsequently accommodate the splenic vein and offer it protection from subsequent compression by the overlying pancreas. We feel that the development of this protected channel is of utmost importance. By trial placements of the splenic vein stump, a suitable site for end-to-side anastomosis with the renal vein is selected so that an anastomosis of maximum obliquity between the splenic vein and the renal vein can be achieved. It is desirable that the splenic vein and the renal vein form an acute angle of roughly 60 degrees. After selection of the site of anastomosis, marking stay sutures are placed in the renal vein, and the vein is tented and grasped by a Beck Potts clamp An end to-side anastomosis is achieved in precisely the same fashion as that described for the portacaval shunt, with the exception that, in children where growth is expected, interrupted horizontal mattress sutures are employed in the anterior row of the anastomosis instead of the continuous over and over everting suture Following completion of the anastomosis, the clamps are removed, and the shunt is carefully examined for deformities which may compromise the efficiency of the shunt The pancreatic tail is allowed to resume its natural position Portal pressures are again taken with and without splenic vein compression, to test the efficiency of the shunt The splenic flexure of the colon is allowed to fall into place, and no effort is made to reperitonize the operative area. The abdominal and thoracic wounds are closed in similar manner to that described for the portal vein-to-vena cava shunt.

END TO SIDE PORTACAVAL SHUNT

A. The patient is placed in the supine position, and the right side is elevated to an angle of 40 to 45 degrees from the horizontal. The thoracoabdominal incision overlying the ninth intercostal space is in dotted outline

B C D The incision is deepened through the subjacent musculature, the costal arch, the diaphragm the pleura, and the peritoneum to expose the underlying intraperitoneal and intrapleural viscera.

E. The liver is displaced downward and then rotated and retracted upward into the adjacent right pleural cavity The hepatic flexure of the colon is mobilized by severance of the right phrenocolic ligament, as indicated in dotted outline.

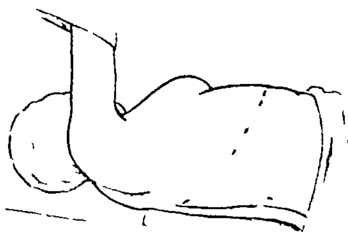
DISCUSSION—DRS. ARTHUR H. BLAKEMORE AND ARTHUR B. VOORHEES, JR. The key to a successful portacaval shunt is a rapidly moving stream of blood. The precise mechanism by which the process of thrombosis is accelerated in a slow-moving stream or retarded in a fast moving stream is not known, but, for practical purposes this observation may be accepted for fact. A high rate of flow can be achieved where the pressure within the portal system is high and the pressure within the vena cava or renal vein is low thereby establishing a satisfactory pressure gradient. A high rate of flow can be further assured by minimizing peripheral resistance, particularly in the portal or the splenic vein. Angulation and constriction of the vein along its course or at the site of anastomosis, or turbulence in the vena cava or renal vein in close proximity to the stoma of the shunt, may spell disaster In the gradual evolution of the portacaval shunt as a surgical procedure we hold the foregoing facts in a position of paramount importance in the planning and execution of the operation.

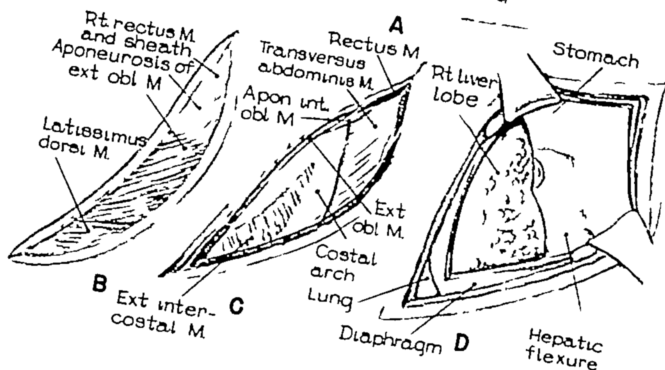
As a result of animal experimentation and observation derived from 350 portacaval shunts in the human, we are convinced that the end-to-side portal vein to-vena cava anastomosis is the most efficient and that the side-to-side portal vein-to-vena cava anastomosis and the end-to-side splenic vein-to-renal vein anastomosis are less efficient. These differences in efficiency are reflections of the rates of flow that can be usually achieved by the three major shunt configurations.

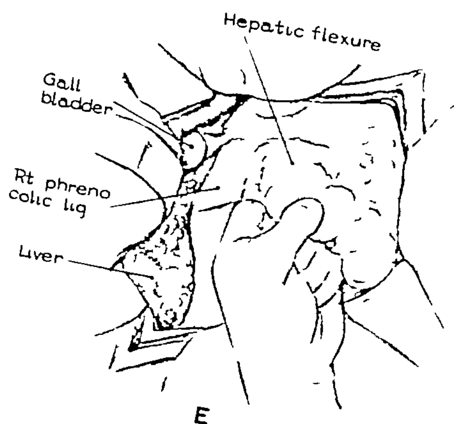
In addition to these broad considerations, scrupulous attention must be paid to the gentle handling of the veins and to the maintenance of aseptic conditions. A crushing forceps or insignificant infection may represent the initial nidus of a subsequently occluding thrombus

General considerations. Strict aseptic technic in the operating room is imperative In addition to the usually accepted methods of skin sterilization and sterile draping, the use of helmets rather than caps, double masks rather than single masks, double glove technic during the skin incision, and skin towels carefully applied by Michel's clips spaced approximately 2 cm apart serve two useful functions. First, this technic minimizes possible contamination of the operative site by bacteria from the skin, nasal and oral pharynx, and the hair Second, if one insists on such a technic, which is somewhat variant from the routine, the operating room personnel is constantly alerted to the need for extraordinary precautions. As a further precaution, 300,000 units of fortified procaine penicillin and 1 gm. of streptomycin are administered intramuscularly to the patient immediately prior to the skin incision. This will provide an adequate therapeutic level of antibiotics within the body during the course of the operative procedure.

Technic of portal vein-to-vena cava shunt. The patient is placed in a supine position on the operating table so that the break in the table or kidney elevator is at the approximate level of the third lumbar vertebra (Fig. 1). A flat sandbag is then placed under the right shoulder and another similar sandbag is placed under the right hip. Side braces, suitably padded, are placed along the left lateral chest wall and at the level of the left hip, thereby permitting subsequent tilting of the table to the left approximately 15 degrees. The right arm can either be suspended from the ether screen or allowed to rest at the patient's side. By breaking the table and elevating the kidney elevator the patient is placed in a hyperextended position. After careful skin preparation and sterile draping, the skin incision is made for the thoracoabdominal approach. The line of incision commences at the anterior axillary line over the ninth rib and is carried obliquely medially across the costal margin to a point approximately 2 to 3 cm. above the umbilicus in the midline of the abdomen. The skin incision is deepened through the subcutaneous tissue to the level of the deep fascia, and, at this point, skin towels are applied with the use of Michel's clips spaced approximately 2 cm. apart. The incision is then deepened through the muscle layers to the level of the periosteum of the ninth rib The periosteum is stripped from the ninth rib, and the rib is transected at the midaxillary line. The rib and its costal cartilage are then resected. Medially the incision is deepened through the oblique musculature, anterior and posterior rectus sheaths, and peritoneum After entry into the peritoneal cavity the remainder of the thoracic portion of the incision is completed by entering the chest cavity through


A


Rt. rectus M. and sheath
Aponeurosis of ext obl M
Latissimus dorsi M.
B
Rectus M
Transversus abdominis M.
Apon int. obl M
Ext obl M.
Costal arch
Ext inter-costal M.
C
Rt liver lobe
Stomach
Lung
Diaphragm
D
Hepatic flexure


Hepatic flexure
Gall bladder
Rt phreno colic lig
Liver
E

END TO SIDE PORTACAVAL SHUNT

A. The patient is placed in the supine position, and the right side is elevated to an angle of 40 to 45 degrees from the horizontal. The thoracoabdominal incision overlying the ninth intercostal space is in dotted outline.

B, C, D. The incision is deepened through the subjacent musculature, the costal arch, the diaphragm, the pleura, and the peritoneum to expose the underlying intraperitoneal and intrapleural viscera.

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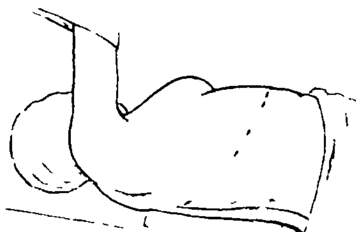
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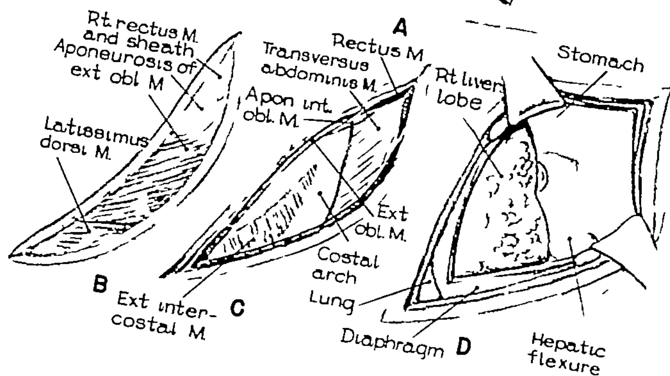
As a result of animal experimentation and observation derived from 350 portacaval shunts in the human, we are convinced that the end-to-side portal vein-to-vena cava anastomosis is the most efficient and that the side-to-side portal vein-to-vena cava anastomosis and the end to-side splenic vein-to-renal vein anastomosis are less efficient. These differences in efficiency are reflections of the rates of flow that can be usually achieved by the three major shunt configurations.

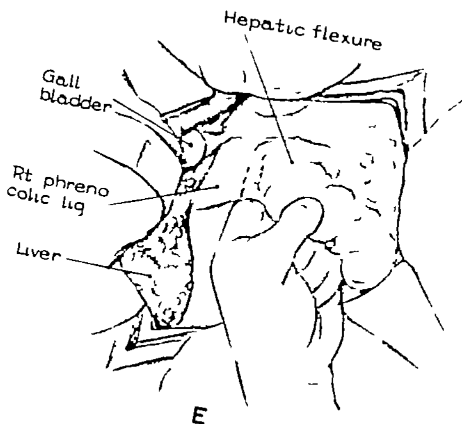
In addition to these broad considerations, scrupulous attention must be paid to the gentle handling of the veins and to the maintenance of aseptic conditions. A crushing forceps or insignificant infection may represent the initial nidus of a subsequently occluding thrombus.

General considerations. Strict aseptic technic in the operating room is imperative. In addition to the usually accepted methods of skin sterilization and sterile draping, the use of helmets rather than caps, double masks rather than single masks, double glove technic during the skin incision, and skin towels carefully applied by Michel's clips spaced approximately cm apart serve two useful functions. First, this technic minimizes possible contamination of the operative site by bacteria from the skin, nasal and oral pharynx, and the hair. Second, if one insists on such a technic, which is somewhat variant from the routine, the operating room personnel is constantly alerted to the need for extraordinary precautions. As a further precaution, 300,000 units of fortified procaine penicillin and 1 gm. of streptomycin are administered intramuscularly to the patient immediately prior to the skin incision. This will provide an adequate therapeutic level of antibiotics within the body during the course of the operative procedure.

Technic of portal vein-to-vena cava shunt. The patient is placed in a supine position on the operating table so that the break in the table or kidney elevator is at the approximate level of the third lumbar vertebra (Fig. 1). A flat sandbag is then placed under the right shoulder and another similar sandbag is placed under the right hip. Side braces, suitably padded, are placed along the left lateral chest wall and at the level of the left hip thereby permitting subsequent tilting of the table to the left approximately 15 degrees. The right arm can either be suspended from the ether screen or allowed to rest at the patient's side. By breaking the table and elevating the kidney elevator the patient is placed in a hyperextended position. After careful skin preparation and sterile draping, the skin incision is made for the thoracoabdominal approach. The line of incision commences at the anterior axillary line over the ninth rib and is carried obliquely medially across the costal margin to a point approximately 2 to 3 cm. above the umbilicus in the midline of the abdomen. The skin incision is deepened through the subcutaneous tissue to the level of the deep fascia, and, at this point, skin towels are applied with the use of Michel's clips spaced approximately 2 cm. apart. The incision is then deepened through the muscle layers to the level of the periosteum of the ninth rib. The periosteum is stripped from the ninth rib and the rib is transected at the midaxillary line. The rib and its costal cartilage are then resected. Medially the incision is deepened through the oblique musculature, anterior and posterior rectus sheaths, and peritoneum. After entry into the peritoneal cavity the remainder of the thoracic portion of the incision is completed by entering the chest cavity through


A


Rt. rectus M and sheath
Aponeurosis of ext obl M
Latissimus dorsi M.
B
Rectus M
Transversus abdominis M.
Apon int. obl. M.
Ext obl. M.
Costal arch
Ext inter-costal M
C
Stomach
Rt liver lobe
Lung
Diaphragm
D
Hepatic flexure


Hepatic flexure
Gall bladder
Rt phreno colic lig
Liver
E

END-TO SIDE PORTACAVAL SHUNT

A. The patient is placed in the supine position, and the right side is elevated to an angle of 40 to 45 degrees from the horizontal. The thoracoabdominal incision overlying the ninth intercostal space is in dotted outline.

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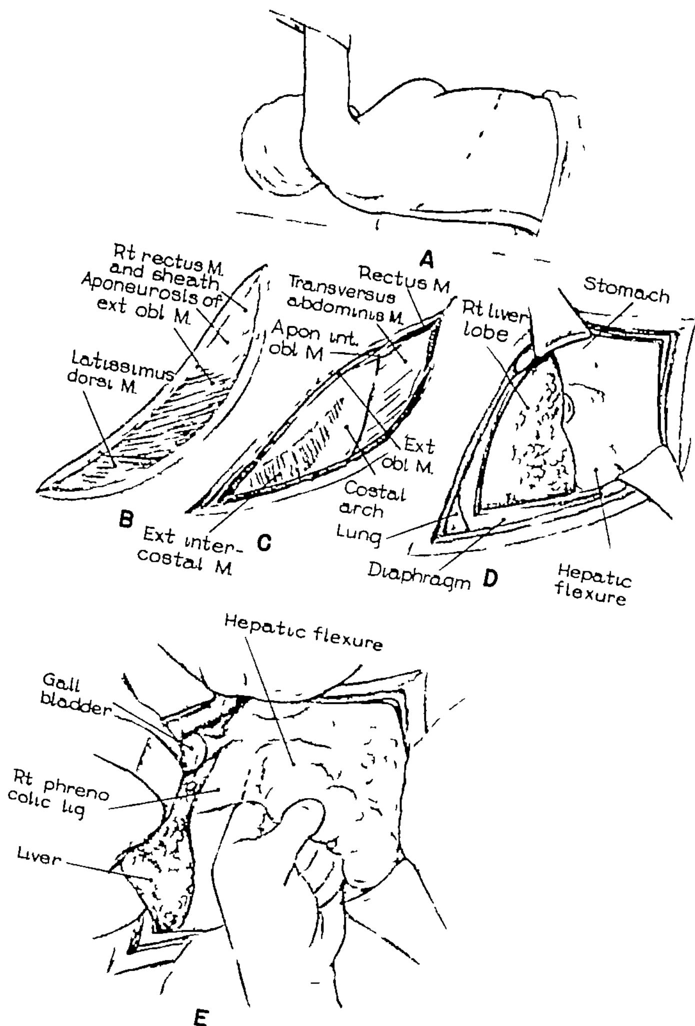
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F The mobilized hepatic flexure of the colon is displaced downward toward the left lower quadrant of the peritoneal cavity and the foramen of Winslow the pylorus, the head of the pancreas, and the retrocolic portion of the duodenum are exposed Mobilization of the descending portion of the duodenum is commenced by scissor dissection *of the posterior parietal peritoneal layer* along its lateral border (Kocher maneuver) Normally this peritoneal layer like the posterior layer of the lienorenal ligament, is avascular and may be severed with impunity However in the presence of portal hypertension, the application of clamps to prevent excessive blood loss may be required.

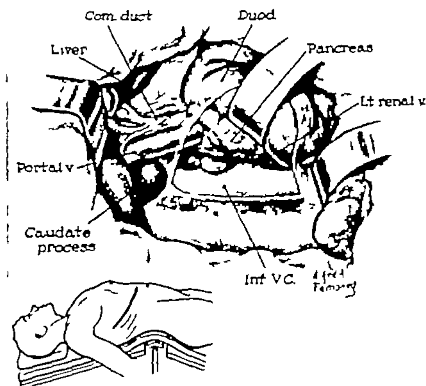
G The mobilized segment of the duodenum and the head of the pancreas are retracted toward the midline to expose the related structures as depicted.

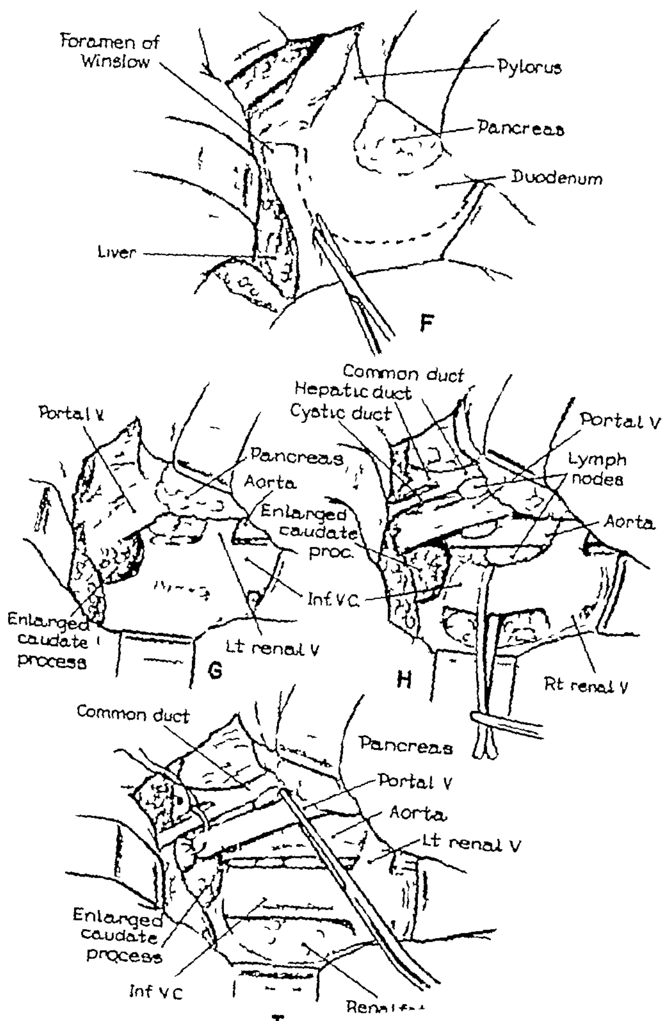
H. The dissection is continued, and the structures are now more clearly visualized The dissection and isolation of the structures shown is both tedious and difficult because of the edema and increased vascularity of the tissues. The mobilized segment of the inferior vena cava is encircled by a traction tape of rubber tissue and partially retracted to expose clearly the group of lymph nodes between the aorta and the inferior vena cava.

I. The portal vein is occluded, first proximally with an angulated Potts ductus clamp and then distally with a ligature and a suture ligature of silk (00) respectively The site for transection of the portal vein is indicated in dotted outline The convergence cephalad of the portal vein and the inferior vena cava and their separation by the caudate process of the liver may be readily seen. In some instances, partial resection of an enlarged caudate process, as suggested by Blakemore, may be required to permit the performance of a portacaval shunt.

DISCUSSION—DRS. BLAKEMORE AND VOORHEES (cont) the bed of the ninth rib, incising the diaphragmatic pleura and peritoneum, and splitting the diaphragm in the course of its muscle fibers for approximately 12 to 15 cm. After general abdominal examination and confirmation of the diagnosis, a specimen for biopsy is obtained from the right lobe of the liver by making a cruciate incision through the liver capsule on the anterior margin and inserting a cork borer of approximately 5 mm. in diameter to the depth of 4 cm. The plug of liver tissue thus obtained is immediately given to the pathologist for early fixation. Bleeding from the biopsy site is controlled by suitably placed mattress sutures tied over a plug of skeletal muscle.

For the sake of convenience, the subsequent operative procedure can be divided into three parts. The first step is that of mobilization of the duodenum and




Foramen of Winslow
Pylorus
Pancreas
Duodenum
Liver
F
Common duct
Hepatic duct
Cystic duct
Portal V
Pancreas
Aorta
Enlarged caudate proc.
Portal V
Lymph nodes
Aorta
Inf VC
Enlarged caudate process
Lt renal V
G
H
Rt renal V
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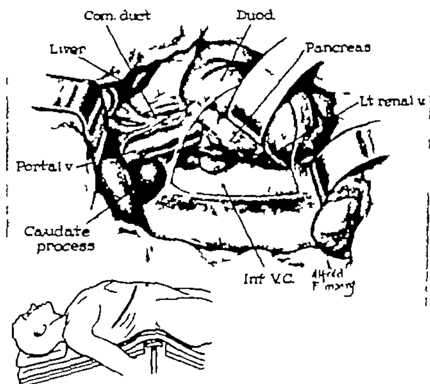
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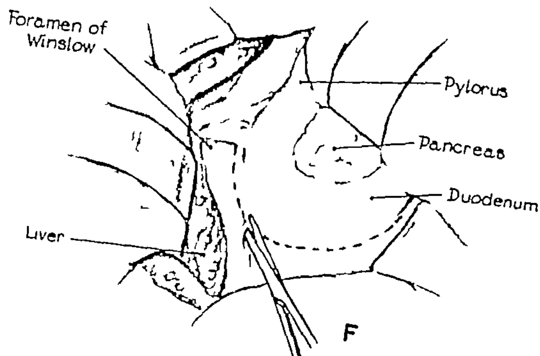
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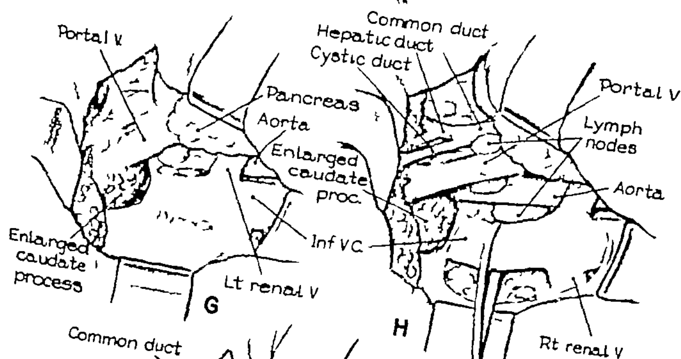
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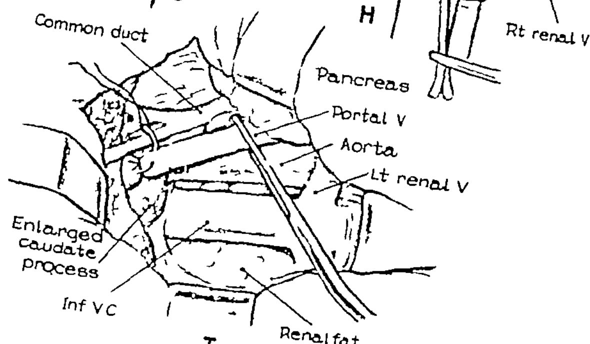
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G
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Hepatic duct
Cystic duct
Portal V
Lymph nodes
Aorta
Rt renal V
H


Common duct
Pancreas
Portal V
Aorta
Lt renal V
Enlarged caudate process
Inf VC
Renal fat

J The whole of the circumference of the inferior vena cava superior to the renal veins is completely mobilized, and its lumen is partially occluded by a Potts–Smith clamp However If desired, a Potts curved portacaval clamp may be used. The advantage of this type of clamp is that a longitudinal segment of the inferior vena cava may be occluded without the necessity of mobilizing the whole of the circumference of the inferior vena cava. The proximal transected end of the portal vein is turned downward toward the inferior vena cava preliminary to the performance of the venovenous shunt. The dotted line in the occluded segment of the inferior vena cava indicates the site of the incision for the anastomosis

K. The posterior suture layer of the anastomosis is inserted. This is a continuous eversion type of suture (silk, 00000) with intima to intima approximation. The suture is commenced from the "outside in" on the portal vein and terminates from the "inside out" also on the portal vein. Between its commencement and termination, the suture proceeds from the "inside out" to the "outside in" relative to the lumens of the portal vein and the inferior vena cava. Accordingly the loops formed by the suture are always on the outside of the lumen of the vessel.

L. The posterior suture a–a, is drawn taut, and the intimal surfaces of the portal vein and the vena cava are in close approximation. *None of the silk suture is exposed within the lumen.*

M. A series of interrupted everting mattress sutures of silk (00000) is employed for the *anterior layer of the anastomosis All of* these sutures are first inserted and then tied. The mattress sutures at either end are tied first, and one of the long ends of each of these sutures is in turn tied to either end, a–a, of the continuous everting suture of silk used for the posterior layer

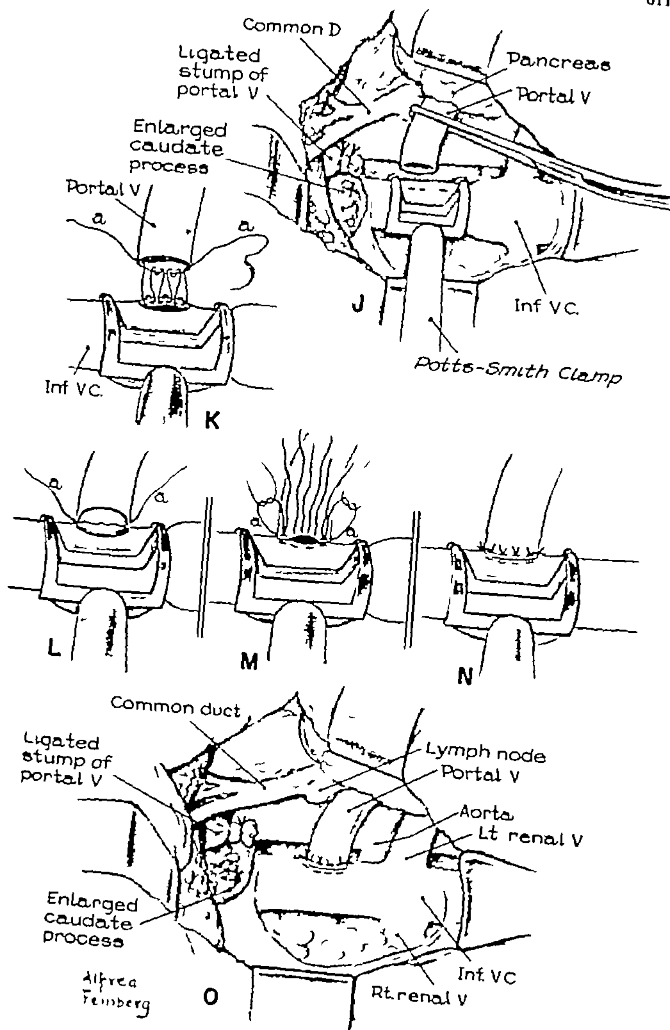
N. The intervening mattress sutures are tied to complete the anterior layer of the anastomosis.

O. The operative field upon completion of the end-to-side portacaval shunt is shown.

DISCUSSION—DRS. BLAKEMORE AND VOORHEES (cont.) identification and partial mobilization of the inferior vena cava. The second step is identification and mobilization of the portal vein. The third step is the anastomosis of the portal vein to the vena cava.

Step 1 (Fig. 1). *The peritoneal reflection overlying* the first and the second portions of the duodenum is *incised along the greater curvature of the first and* second portions of the duodenum By blunt and sharp dissection, the first and second portions of the duodenum are rolled toward the midline. When the under surface of the pancreas can be identified along the lesser curvature of the duodenum, the medial mobilization of the duodenum has been sufficient. With the duodenum in its medial reflected position, the vena cava lies immediately posterior to the area from which the second portion of the duodenum was reflected. The overlying strands of areolar tissue can be divided with safety along the anterior midline of the vena cava. If the right spermatic or ovarian vein is visible, the anterior mobilization of the vena cava has been begun too far caudad. For the purposes of the operation, it is usually sufficient to mobilize only the anterior and medial aspects of the vena cava from the level of the left renal vein to the caudate isthmus of the liver Mobilizing the right lateral aspect of the vena cava in this region is unnecessary and extremely hazardous because of the numerous veins coming from the adrenal gland and entering the vena cava directly It is also important to identify with precision the left renal vein since it will subsequently represent a landmark in selection of the site of anastomosis. In certain patients, hypertrophy of the caudate process may encroach upon the subsequent site of anastomosis, and, in these instances, the caudate process must be resected (Fig. 2). When this is the case, it is necessary to ligate two or more pairs of *minute veins running from the caudate process to the* vena cava. These are frequently unrecognized during manipulation of the process and may be torn, giving rise to troublesome hemorrhage in an area difficult to control. Once the caudate process has been freed from the underlying vena cava, it can be cross-clamped and resected. Hemostasis is achieved by multiple vertical mattress sutures placed approximately 1 cm. from the cut margins.

Step 2 It must be remembered that, with the patient in a *hyperextended left semilateral position,* the operator is usually looking at the right lateral aspect of the hepatoduodenal ligament, and, in this position, the common duct lies in an anterior location and the portal vein in a posterior location in the ligament (Fig. 1). The peritoneal investment of the hepatoduodenal ligament is incised in the posterior right lateral aspect of the hepatoduodenal ligament from the porta hepatis to the greater curvature of the duodenum. In making this incision, care should be exercised to avoid cutting unnecessarily any recognizable lymphatic channels. Once the peritoneum is incised, the vein can usually be identified by finger dissection and palpation. Upon identification, the


Common D
Ligated stump of portal V
Enlarged caudate process
Portal V
a
a
Pancreas
Portal V
J
Inf VC.
Potts-Smith Clamp
Inf VC.
K
a
a
L
a
a
M
N
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Lymph node
Portal V
Aorta
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Enlarged caudate process
Inf. VC
Rt. renal V
O
Alfred Feinberg

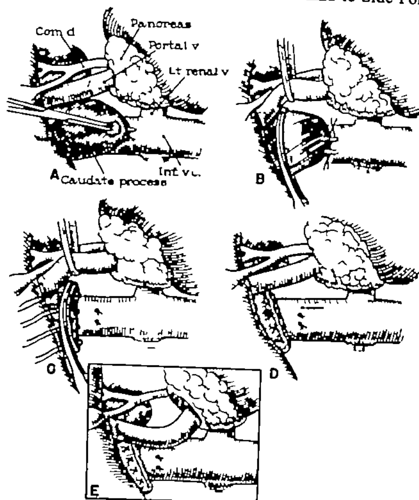
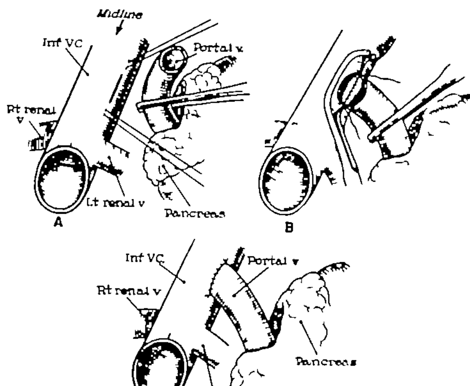

Com d
Pancreas
Portal v
Lt renal v
Inf v c
A
Caudate process
B
C
D
E

Fig. 2.


Midline
Inf VC
Portal v
Rt renal v
Lt renal v
Pancreas
A
B
Inf VC
Portal v
Rt renal v
Pancreas

vein should be dissected bluntly in the adventitial plane at roughly its midportion between the porta hepatis and the head of the pancreas. Following local circumferential dissection of the vein, a short piece of umbilical tape can be passed about the vein for the purpose of gentle traction. This serves as a useful method for avoiding unnecessary instrumentation of a vein subsequently to be used as a shunt. The dissection is carried cephalad to the porta hepatis. *The bifurcation of the portal vein into the right and left hepatic veins should be identified.* This represents the highest point of dissection, and at this time there are usually no significant venous tributaries which must be dealt with. The portal vein is mobilized caudad by sharp and blunt dissection to the level of the head of the pancreas. Two major tributaries to the portal vein, if unrecognized, may tear and cause troublesome hemorrhage. The first tributary is on the medial aspect of the portal vein and enters directly into the head of the pancreas. The second tributary is on the lateral inferior aspect of the portal vein, just beneath a collar of pancreatic tissue where the portal vein emerges from the head of the pancreas. Both tributaries should be identified and individually ligated by transfixion ligatures of 00000 braided silk. After mobilization of the portal vein, it is appropriate to make initial pressure readings in the portal system from a large branch of the gastroepiploic vein. Simple manometric readings, using the manubrial notch as the reference point, should be made with the portal vein open and then with the portal vein compressed. If the pressure rise following compression of the portal vein is in excess of 150 mm. of saline then a side to-side portal vein to-vena cava anastomosis is advised. As the last portion of this second step in preparation for an end-to-side anastomosis, a ligature of heavy silk is passed about the portal vein at the level of the bifurcation into the right and left hepatic veins. The ligature is tied, and a second transfixion suture employing 00 braided silk is placed approximately 3 mm from the primary tie. A rubbershod clamp that will occlude, but not crush, the vein is placed around the vein as it emerges from the head of the pancreas, and the vein is transected immediately proximal to the transfixion suture. Twenty to thirty millimeters of a solution of heparin containing 10 mg. of heparin in 100 ml of saline is instilled in the portal vein proximal to the rubbershod clamp

Step 3. An imaginary line coursing parallel to the vena cava on its anterior medial aspect, equidistant from the true anterior aspect of the vena cava and the true left lateral aspect of the vena cava, which *may be indentified by the juncture of the left renal* vein, is defined and marked by two arterial silk sutures as the future axis of the anastomosis (Fig. 3). The vena cava is tended and grasped by a Beck-Potts clamp An oval "window" is then cut in the vena cava, corresponding in diameter to the fully distended portal vein. The anastomosis is placed as near to the liver as practical so that the angle formed between the portal vein and the vena cava will be an acute angle 45 to 60 degrees. A single layer anastomosis is achieved by a simple over and over suture of 00000 braided silk. It is desirable to exert some tension on the angle stay sutures during the anastomosis to avoid pursestringing the stoma. In the posterior suture line, care must be exercised to avoid dragging small strands of adventitial tissue into the suture line by the suture material. After completion of the anastomosis, the vena cava clamp is released first, and the portal vein clamp released second. Anastomoses in a low pressure system rarely leak seriously and minimal suture line leaks occurring shortly after the removal of the clamps should be controlled by simple finger pressure over the area. Unless the suture line leak is a serious one, reinforcing sutures should not be taken since they may cause distortion or constriction of the stoma. Once flow has been established in the newly formed shunt, the point of emergence of the portal vein from the region of the head of the pancreas should be carefully examined. Frequently a collar of pancreatic tissue will cause angulation or actual compression of the portal vein in its newly established course. If this collar exists, a wedge of pancreatic tissue should be excised (Fig. 4). This compression feature is an exceedingly important one

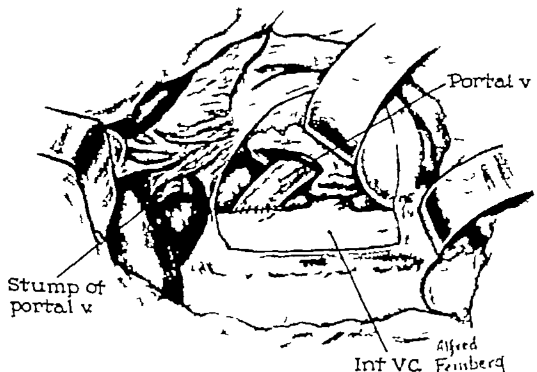


Fig 4

Discussion—Drs. Blakemore and Voorhees (cont.)

and may not be recognized by a cursory examination It must be actively looked for

In those instances where side-to-side anastomoses between the portal vein and the vena cava are *deemed advisable because of a pressure rise in the* portal system in excess of 150 mm. of saline following compression of the portal vein, the portal vein is not divided. Contiguous surfaces of the vena cava and portal vein are marked by arterial sutures, the *vena cava is grasped by a Beck-Potts clamp in a* fashion similar to that previously described, and a 15 mm. diameter oval "window" is cut (Fig. 2). The portal vein is temporarily occluded above and below the site of anastomosis by a simple double turn of umbilical tape, and a corresponding *15 mm. diameter* oval "window" is cut in the previously marked site. The anastomosis is accomplished in precisely the same manner as that described for the end to-side anastomosis.

After completion of the portal vein-to-vena cava shunt, manometric pressures are again recorded in the portal system, with and without portal vein compression. In ideal circumstances, the pressure in the *portal system should be less than 200* mm. of water pressure. If this pressure has not been achieved, the possibility of mechanical impediment to flow by distortion of the portal vein, or at the site of anastomosis, should be excluded by inspection. In the *closure of the operative wound,* no attempt is made at reperitonization or closing the retroperitoneal tissues over the site of anastomosis. The abdominal and thoracic portions of the wound are anatomically reconstituted. The abdomen is closed without drainage, *and the chest cavity is closed* over a large caliber catheter which is withdrawn at the conclusion of the chest closure after residual air and fluid have been evacuated from the cavity

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MODIFIED KONDOLÉON OPERATION

A. The skin incision (solid line) on the medial aspect of the left leg and foot is deepened by scalpel dissection into the superficial subcutaneous fatty tissue plane.

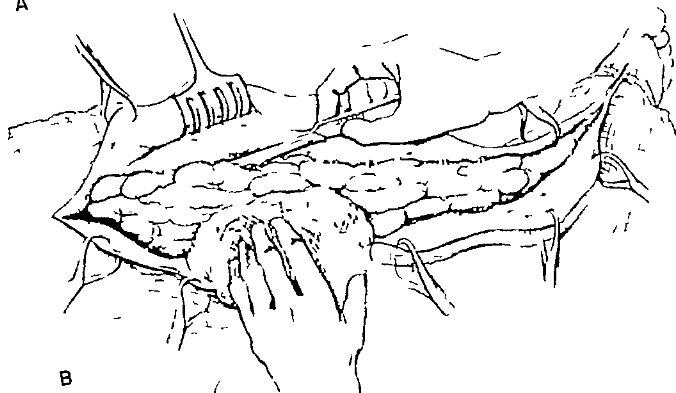
B. Folded moist towels are secured to the skin margins of the incision by towel clamps, and, with upward traction maintained first through the clamps and subsequently by multipronged (rake) retractors, the skin flaps are mobilized from the surface of the lymphedematous tissue to the midline both anteriorly and posteriorly

C. The mobilization of the skin flaps is completed, and the mass of lymphedematous tissue and underlying deep fascia is removed by scalpel dissection from the surface of the subjacent muscles.

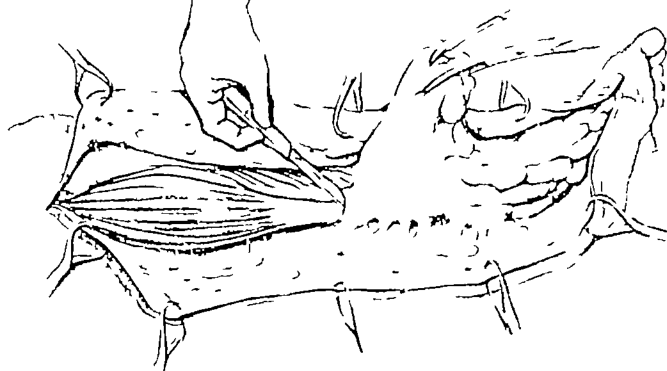
Plate 284



A



B

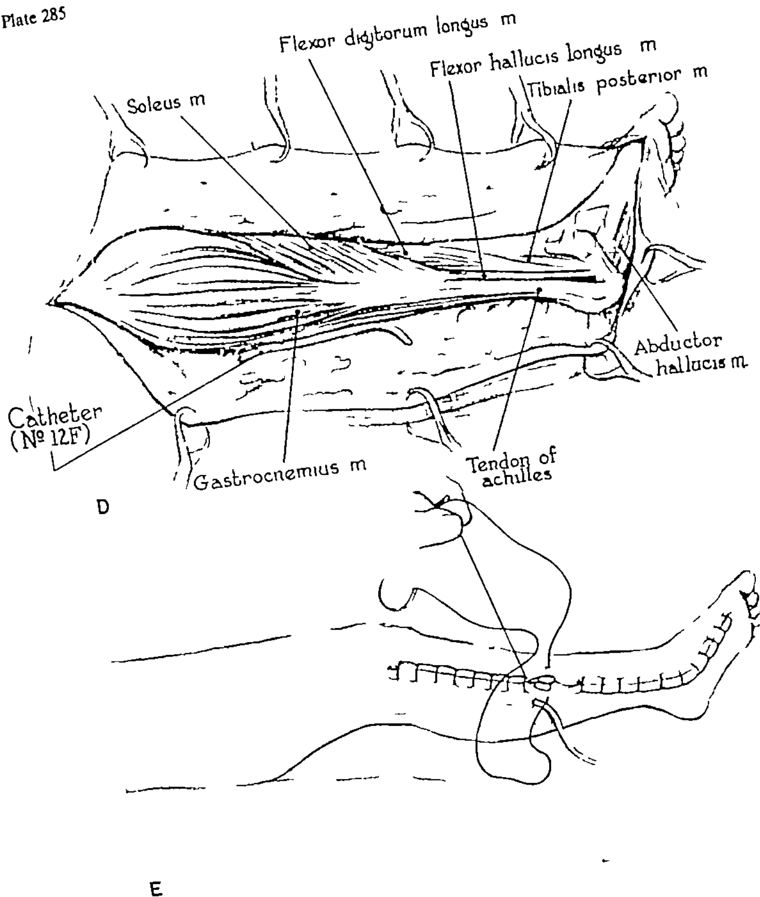


C

D. The excision of the lymphedematous tissue and deep fascia is completed, and the muscle structures of the medial aspects of the leg and foot are exposed. Small islands of fat may be seen adherent to the undersurface of the skin flaps. A catheter (12 F) with multiple openings in its tip is partially withdrawn through a stab wound opening in the lower skin flap for continuous suction drainage.

E. The skin flaps are approximated from either end of the incision toward the center with continuous interlocking sutures of 00 silk. The application of a compressive bandage completes the operation. Approximately four to six weeks later a similar operation is performed on the lateral side of the leg and foot.

Plate 285

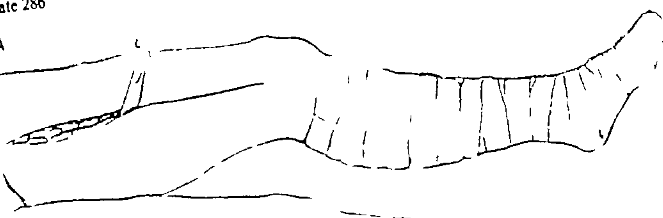

Flexor digitorum longus m
Flexor hallucis longus m
Tibialis posterior m
Soleus m
Abductor hallucis m
Catheter (No 12F)
Gastrocnemius m
Tendon of achilles
D

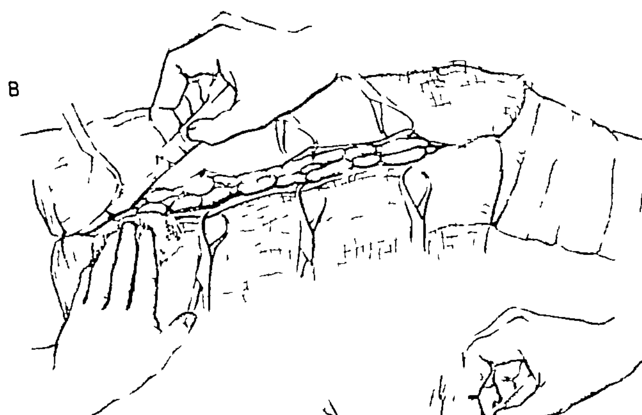
E

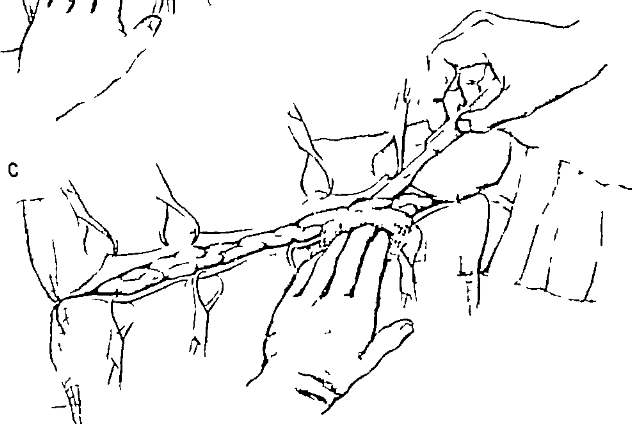
A. The first and second stage operations on the medial and lateral aspects of the leg and foot respectively are completed, and, four to six weeks after the second stage operation on the leg, the third stage operation on the inner aspect of the thigh is performed. The incision on the medial aspect of the thigh (solid line) midway between its anterior and posterior surfaces is being deepened by scalpel dissection into the superficial subcutaneous fatty tissue plane.

B, C. Similarly as in the leg, moist folded towels are secured to the skin margins with towel clamps. Traction is maintained upward on the clamps as scalpel dissection is continued in the tissue planes between the skin flaps and the lymphedematous subcutaneous fatty tissue

ate 286



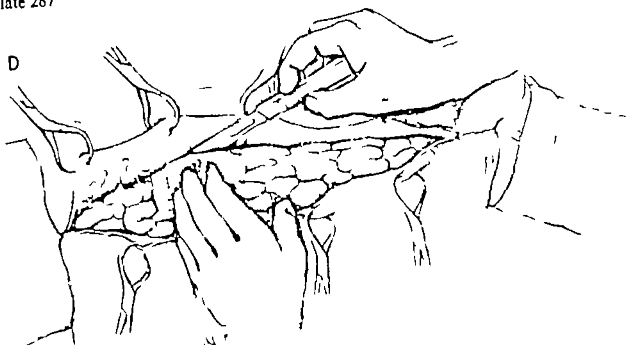


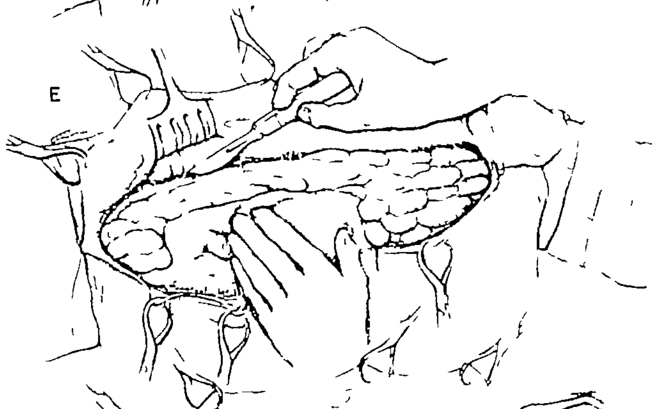


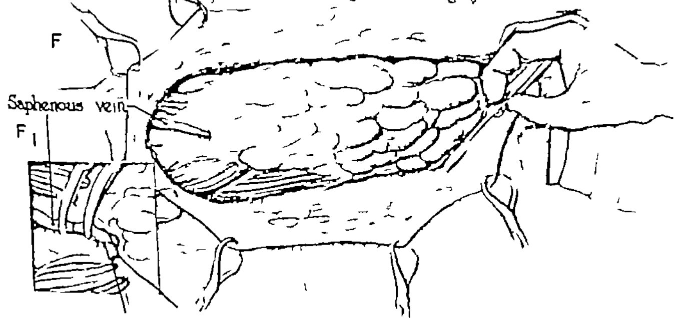
D E. The scalpel dissection immediately subjacent to the skin flaps is progressively deepened (D), and as the dissection progresses, multipronged (rake) retractors are used to elevate the partially mobilized skin flaps (E). The dissection of the skin flaps is continued to the midline on the anterior and posterior surfaces of the thigh.

F F_1. The mobilization of the skin flaps is completed, and a segment of the saphenous vein in the upper medial aspect of the thigh is visible (F). An untied ligature is applied to the caudal portion of the exposed proximal segment of the saphenous vein, and the vein is doubly clamped and severed as indicated by the dotted line (F_1). The severed ends of the vein are doubly occluded with ligatures and suture ligatures respectively of 000 silk. Each suture ligature is inserted between the occluding silk ligature and the clamp, which is removed as the suture ligature is tied.

Plate 287







G H. The cephalad margin of the lymphedematous tissue is grasped in clamps, and, as downward traction is maintained, it is removed en bloc with the underlying fascia from the subjacent muscles by scalpel dissection.

DISCUSSION—DR. GERALD H. PRATT The author's incision, as shown in Plate 286A, is in the classic medial position. At times, we have placed this incision directly in the midline of the back of the leg to correspond to the suture line of a stocking. This also permits equal sized flaps to be raised medially and laterally around to the tibia. Plate 286B shows the raising of these flaps with the typical "pigskin" appearance of the denuded skin, indicating that all possible fat and fascia have been removed from the skin flap itself. The removal of all of the superficial and deep fascia en bloc is then shown In B one can see some fat and tissue globules still left on the elevated skin flaps which we feel should be removed subsequently Many fat collections are found in the layers between and under the muscles, and, in our experience, any fat retained will cause lymphedema to recur Plate 285D demonstrates well all the muscles which can be seen at this operative intervention. Sometimes we retain the saphenous vein as a help in subsequent drainage. Phisohex whirlpool baths will help clean the first operative area between stages.

In the thigh, the removal of the fascia is not nearly as difficult as it is below the knee, where the fascia itself also becomes muscle fascia. It is extremely important that all of this fascia and fat be excised. The muscle demonstration in Plate 289 I is excellent. We remove all the fat on the skin and all the fat between those muscle bundles. The excessive skin must be removed prior to approximating the skin edges.

Individual variations exist in surgeons technics. We leave small strips of fascia over the tendon Achilles and the peroneus muscles at the ankle to prevent the tendons from bowing out. We use no drains, feeling that a drain may be a portal of entry for infection in these limbs already depleted of their lymphatic defenses by their disease. The utilization of interrupted fine steel wire sutures (No 36) inserted loosely reduces, we feel, secondary tissue reaction to suture material. This is an individual variation in technic. We bevel the remaining tissue at the incision margin so there is not a sudden change in the size of the leg from the nonoperative to the operative area.

Some years ago, after performing a large number of these operations by the technic described, we found the recurrence rate quite high. The recurring attacks of cellulitis continued, and the overall results were not satisfactory A much more radical procedure was then performed and described. By biopsy we found that lymph did not accumulate in the epithelium of the skin until a depth of 1/50 of an inch was reached. Therefore, with an electric dermatome, the epithelium was removed at only 15/1000 of an inch in depth. The second finding was that all fat and all fascia accumulate lymph in lymphedema. We removed all such tissue down to the denuded red muscles. The operation, then, consists of removing all of the skin with an electric dermatome set at 15/1000 of an inch thickness and then removing all of the rest of the skin, superficial and deep fascia, as well as all the fat. The same thin epithelial covering is then replaced directly on the denuded red muscle. Other technics retained either deep or muscle fascia.

While this operation resulted in some keloiding and occasional dermatitis, due to the fact that the skin was of poor texture, the reduction in size was satisfactorily maintained if all of the fat and fascia were removed. Lymphangitis attacks often continue to occur after any operation due to the fact that the lymphatic defense in these limbs is inadequate. This complication can be relieved by use of long term antibiotic therapy giving the drugs just before cellulitis should develop as determined by a fever bout calendar We reserve this more radical technic, however for those patients who have tremendous lymphedemas and those in whom recurrence has resulted after the method described by the author Only in the mild lymphedemas have we been able to effectively do away with the grotesque enlargement by the method described. Elevation and support continue to be necessary in most patients for an indefinite time.

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Plate 288

G

H

I. The excision of the lymphedematous tissue and underlying fascia is completed to expose the subjacent muscle structures on the medial aspect of the thigh. A catheter (No 12 F) for continuous suction drainage is inserted through a stab wound in the lower flap

J The skin incision is closed, using a continuous interlocking suture of 00 silk. Upon completion of the closure of the skin incinon, a compressive bandage is applied. The fourth and last stage of the operation is performed on the lateral aspect of the thigh four to six weeks later

The technic illustrated is preferred to the removal of split thickness (0.020 inches) skin grafts which are applied directly to the subjacent muscle structures after excision of the lymphedematous tissue and underlying fascia. The postoperative results following this operation have proved unsatisfactory because of the high incidence of recurrent attacks of cellulitis, excessive keloid formation, prolonged disability and persistent enlargement of the extremities.

In the elevation of the skin flaps as depicted in the illustrations, areas of necrosis of varying sizes frequently occur along the line of the incision. However subsequent skin grafting to cover the resulting tissue defects is only occasionally required. In general, the overall results with the use of the illustrated modification of the Kondoléon operation have proved most satisfactory

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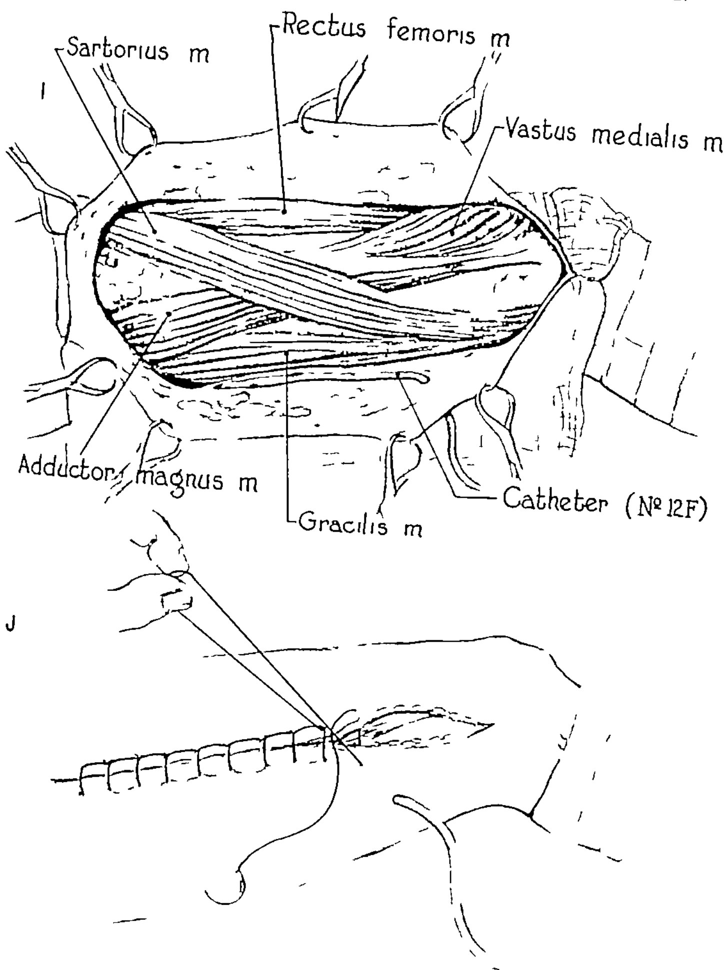
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I
Rectus femoris m
Sartorius m
Vastus medialis m
Adductor magnus m
Catheter (№ 12F)
Gracilis m
J

LEFT LUMBAR SYMPATHETIC GANGLIONECTOMY

A. The patient is placed in the supine position, and the left side is elevated on a pillow support to approximately a 25 degree angle to the horizontal.

B. Traction with a multipronged (rake) retractor is maintained upward on the upper flap as its mobilization is completed by scalpel dissection. The lower flap was previously mobilized in like manner

C. The outer angle of the incision is also mobilized by scalpel dissection until the musculature of the lateral abdominal wall is readily visible

D The mobilized skin margins are retracted, and the incision in the external oblique muscle in the direction of its fibers is visible This incision is always made through the muscle fibers and never through the aponeurosis, which is located medially

E. The separated fibers of the external oblique muscle are retracted to expose the opening in the internal oblique muscle layer through which the underlying fibers of the transversus abdominis muscle are visible. The internal oblique is the thickest and the transversus abdominis is the thinnest of the three muscle layers that are to be separated.

F The muscle fibers of the internal oblique are separated by finger dissection, and care is observed to avoid avulsion of the underlying intercostal nerves between which an opening is made through the fibers of the transversus abdominis muscle. The dissection of this muscle is begun laterally and continued medially to lessen the possibility of opening into the peritoneal cavity The opening in this muscle layer exposes a portion of the irregular line of overlap of the retroperitoneal fat on the lateral parietal peritoneum.

G The muscle layers are retracted, and the transversalis fascia overlying the retroperitoneal fat is severed by scissor dissection. A herniation of a portion of the retroperitoneal fat through the opening made in the transversalis fascia is visible.

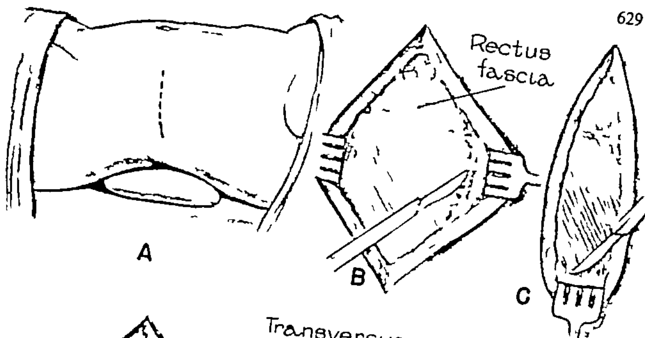
DISCUSSION—DR GERALD H PRATT We have found spinal anesthesia not only safe, but one which, by its muscle relaxation, makes the operation technically easier The level of anesthesia must be to the fourth or fifth dorsal nerves. A hypobaric solution permits the operative area to be elevated at once. The patient is placed on the table at a 45 degree angle to the operator by placing a sandbag underneath the hip and shoulder The table is then broken, and the hand on the operator's side is raised high above the patient's head to pull the lower ribs out of the way In this position, the space between the last ribs and the crest of the ilium, which is normally only about 2 inches, can be widened to 4 or 5 inches, and the lumbar spine is brought quite close underneath the operative incision

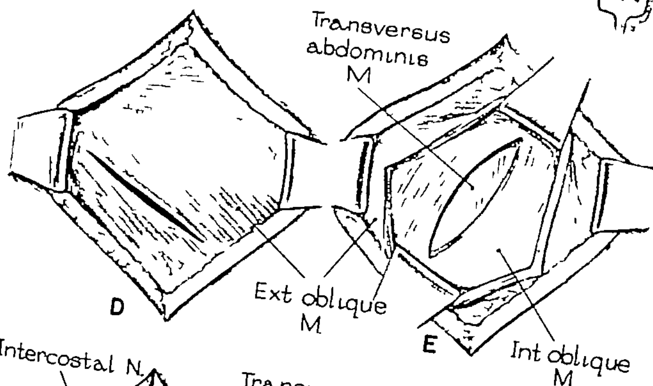
We use approximately the same incision for lumbar sympathectomy as the author a transverse one made in the line of the skin cleavage at the level of L-2 If the separation of the external oblique muscle, the most restricting of the muscles, is extended longer than that through the other lateral abdominal muscles, the wound can be moved to excise a ganglion found anatomically higher or lower than usual.

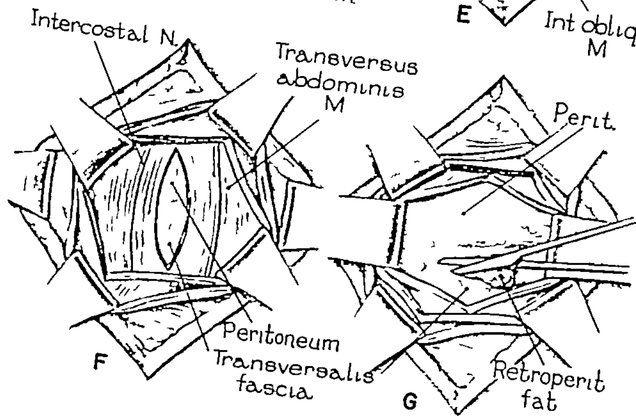
On the transversalis muscle and fascia lie the intercostal nerves and blood vessels. These nerves and vessels can be protected by making the transversalis incision between them, thus preserving the nerve supply to the muscles and also reducing the incidence of a painful neuritis. If the level of spinal anesthesia is slightly lower than desired, these nerves can be injected with procaine to avoid the addition of a general anesthesia, which we consider to be an added danger

Mounted damp sponge sticks are adequate dissectors for moving the peritoneum and its contents forward without injury to the peritoneum. One must avoid dissecting behind the iliacus or between the iliacus and the psoas muscles.

Any dissection of the vena cava must be gentle since its lumbar branches are thin and easily torn. We dissect the upper part of the chain first follow-


Rectus
fascia
A
B
C


Transversus
abdominis
M
Ext oblique
M
D
E
Int oblique
M


Intercostal N.
Transversus
abdominis
M
Perit.
Peritoneum
Transversalis
fascia
F
G
Retroperit
fat

H. By blunt digital dissection in the retroperitoneal fat, the peritoneum and the adjacent intraperitoneal viscera are displaced toward the midline. During this dissection, the important landmark is the psoas major muscle, which is located more anteriorly than one generally assumes. The tissue dissection is continued anteriorly and medial to this muscle; otherwise, troublesome technical difficulty may ensue.

I. The peritoneum and the related intraperitoneal viscera are retracted toward the midline to expose the left ureter which overlies Gerota's fascia. The ureter is always first identified before being retracted from the operative field. The adjacent related structures are readily demonstrable.

J. The ureter is retracted medially. The line of the incision to be made in the fascia of Gerota is indicated by the dotted line.

K. The incision in Gerota's fascia is completed, and, by blunt dissection with a long tissue forceps (deleted for clarity) in the underlying fatty areolar tissue, the lumbar sympathetic trunk and the lumbar vessels are exposed along the anterolateral surface of the vertebral column. Further identification of the sympathetic trunk may be obtained by digital palpation against the sides of the lumbar vertebrae. The genitofemoral nerve, frequently mistaken for the sympathetic trunk, may be seen coursing downward and lateralward along the medial aspect of the psoas muscle. This nerve is white in color, nonganglionated, easily mobile, always on muscle (psoas), and directed downward and lateralward. Contrariwise, the lumbar sympathetic trunk is yellowish-white in color, ganglionated, and located on the anterolateral aspect of the bodies of the lumbar vertebrae and never on muscle. Furthermore, it is taut and relatively fixed in position by the attachment of the rami communicantes to their respective ganglia and is the most posteriorly situated structure along the vertebral column. Finally, its direction is downward and slightly medialward. These anatomic differences should serve to differentiate the genitofemoral nerve from the lumbar sympathetic trunk.

L. The sympathetic trunk is mobilized on a nerve hook, and, with upward traction maintained, the anchoring rami communicantes are severed with a curved knife blade (No. 12).

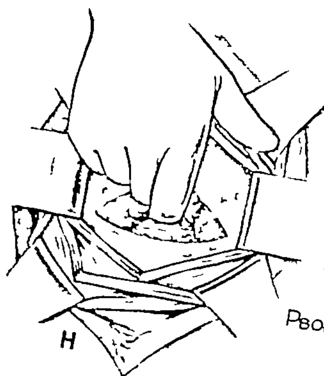
Discussion—Dr. Pratt (cont.)

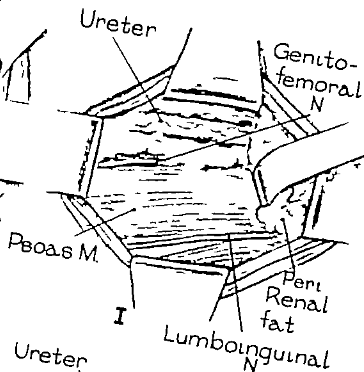
ing it as high as possible, usually to the diaphragm. To increase the extent of sympathectomy, we avulse or exerese it from its surrounding tissue, and, if the pull on the chain is directly in the line of its fibers, the maneuver does not tend to lacerate any vessels.

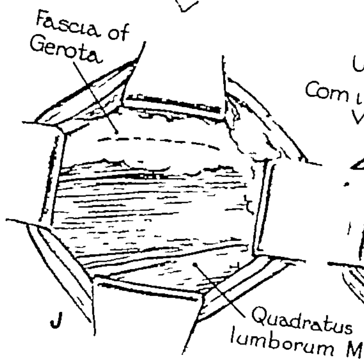
The so-called fool's sympathetic, the genitofemoral nerve, is seen lying on the muscle in contradistinction to the chain which is in close approximation to the periosteum of the vertebrae with its enlargements (ganglia). The chain has a characteristic feeling to the palpating finger. We do not remove any structure as a chain until it is further identified manually by rubbing it against the vertebrae and feeling its cord, not unlike the vas deferens.

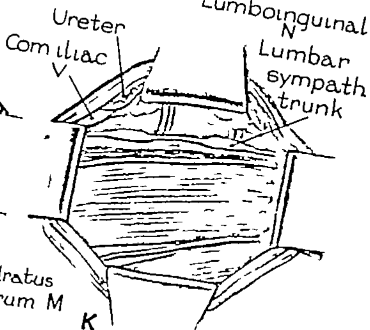
The artist's drawing depicts the sympathetic chain as a single nerve with ganglia. More often it is found as a plexus of nerve fibers with several communicating branches entering the main trunk above and below the ganglia. We feel it is important to remove all such fibers, even those that cross to the other side. Thus the lumbar sympathetic nerves are a plexus and not just a nerve with ganglia. There can be from two to eight ganglia in the lumbar area, and all the fibers should be removed in order to do a complete operation. In many instances, a repeat lumbar sympathectomy has been effective, the preceding operation having only removed one or two ganglia with a continuation of sympathetic effect by collateral sympathetic nerves. Identification of the upper and lower ends of the resected sympathetic chain by a silver clip is practical, as the author has pointed out, and also prevents an annoying hemorrhage from an accompanying vessel. The author brings attention to the variations of the anatomy in the right and left sides and the danger of injuring vertebral veins. The removal of the underlying chain by dividing it at the overlying vein and teasing it under the vein is a safe measure, if done carefully. While these lumbar veins can be clamped and divided, an attempt at their ligation is fraught with danger. Serious complications have developed from trying to ligate small lumbar veins. Silver clips are best used at this stage for hemostasis. These veins in themselves are small, but they open directly into the vena cava. If these veins tear, one has a laceration in the wall of the vena cava, and the small vein stump retracts and is a hole in the cava. In cases of serious hemorrhage, packing is advisable, at least until blood for transfusion is available. This venous bleeding can be controlled by a hemostatic pack, while a laceration from traumatic tearing of a hastily applied clamp on the vena cava might be serious or even fatal.

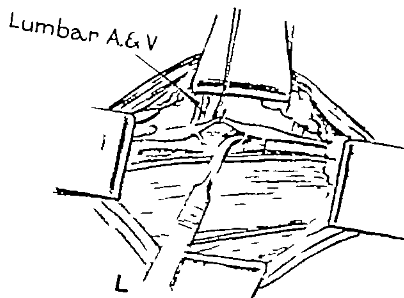
In closing the wound, one should again be careful to prevent inclusion of the nerves on the transver


H


Ureter
Genito-femoral N
Psoas M
Peri Renal fat
Lumboinguinal N
I


Fascia of Gerota
Quadratus lumborum M
J


Ureter
Com iliac V
Lumbar sympath trunk
K


Lumbar A&V
L

M. Upon completion of the mobilization of the lumbar sympathetic trunk, a Cushing silver brain clip is applied proximally and, immediately below the clip the trunk is severed by scissor dissection.

N. Similarly a silver clip is applied distally immediately above which the trunk is severed.

O P Q R. On removal of the retractors, the separated fibers of the various muscle layers tend to approximate themselves. The wound closure is in layers using interrupted sutures of silk (000) for the transversus abdominis muscle (O), the internal oblique muscle (P), the external oblique muscle (Q), and the skin (R). The relation of the intercostal nerves to the line of closure of the transversus abdominis muscle is visible (O).

DISCUSSION—DR. PRATT (cont.)

salis muscle in the sutures because of the subsequent annoying neuritis. We close the transversalis with chromic catgut and the rest of the layers with No. 32 stainless steel wire. We believe this technic has removed the wound reaction that some elderly patients evince.

The use of spinal anesthesia, good operative position, a careful study of the anatomy light hands on the retractors, and care in avoiding laceration of lumbar veins will prevent most of the usual complications. We know of four ureters removed as sympathetic chains, and nearly every type of fascia, muscle, nerve, blood vessel, and lymphatic vessel has been removed and sent to the pathologist as a sympathetic ganglia.

It is our Clinic's teaching that many of the poor results attributed to sympathectomy are due either to inadequate sympathectic denervation or too long delay in the use of this operative intervention.

The author's technic is fundamentally excellent, and the results when it is followed correctly will be good.

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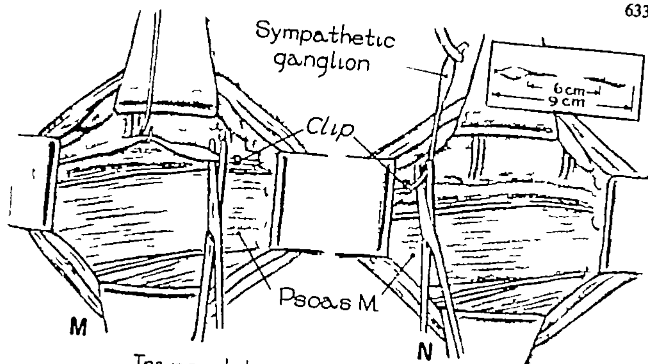
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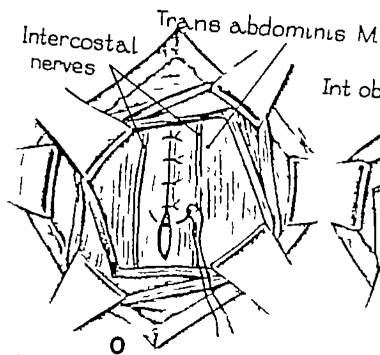
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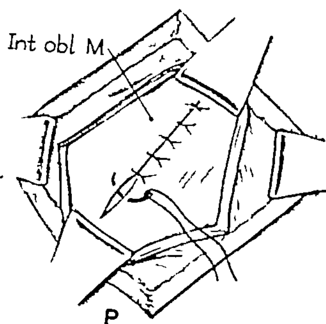
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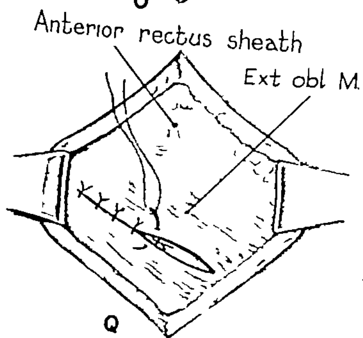
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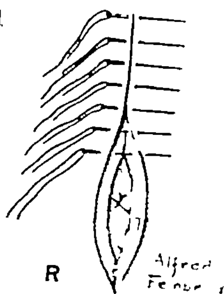
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Sympathetic ganglion
6 cm
9 cm
Clip
Psoas M
M
N


Intercostal nerves
Trans abdominis M
O


Int obl M
P


Anterior rectus sheath
Ext obl M
Q


R

RIGHT LUMBAR SYMPATHETIC GANGLIONECTOMY

A. The incision on the right side is similar to the one employed in the performance of a left lumbar sympathetic ganglionectomy It extends laterally from the outer border of the right rectus at the level of the umbilicus to the midaxillary line at a point midway between the costal arch and the iliac crest.

B. The muscles of the anterolateral abdominal wall are split in the direction of their fibers and retracted. The beginning of the blunt digital dissection in the retroperitoneal space is shown, and the lower pole of the right kidney enveloped in the perirenal fat, may be seen.

C. The dissection in the plane of the retroperitoneal fat is completed, and the ureter is visible along the anterior surface of the inferior vena cava, which is covered by the fascia of Gerota and underlying fatty areolar tissue.

D The ureter is retracted The line of incision in Gerota s fascia is represented by the dotted line

E. Gerota s fascia is opened, and the inferior vena cava is retracted medially The lumbar sympathetic trunk is secured on a curved nerve hook, and upward traction is maintained as the chain is mobilized by severing the rami communicantes using a curved knife blade (No 12). The silver clip shown on the distal portion of the chain is applied immediately below the site of election for transection after this portion of the chain is completely mobilized

F The sympathetic trunk, severed distally is mobilized proximally and a silver clip is applied to the trunk just cephalad to the site of its transection. The relation of the adjacent genitofemoral nerve (nonganglionated) to the underlying psoas muscle and its downward and lateral direction are visible.

G In this illustration, an alternate relation of the lumbar sympathetic trunk to the vertebral vessels is demonstrable One may note in particular that the distal portion of the sympathetic trunk is posterior to the vertebral vessels. This is not uncommon on the right side, but it is infrequent on the left. Accordingly on the right side caution should be observed in the mobilization of the lower portion of the trunk. It should not be mobilized by avulsion because of the possibility of injury to the lumbar vessels. When the vessels are anterior in order to remove the trunk completely it is necessary either to sever the chain above and, by traction below deliver it from behind the vessels, or to doubly clamp sever and ligate the overlying vessels When severance of the vessels is indicated, preferably they are severed between hemostatic brain clips (Cushing).

H. Following the sympathectomy the wound is irrigated with saline solution, and complete hemostasis is obtained. The retractors are then removed, and the wound closure is performed in layers, using interrupted sutures of 000 silk as previously described in the closure of the left side.

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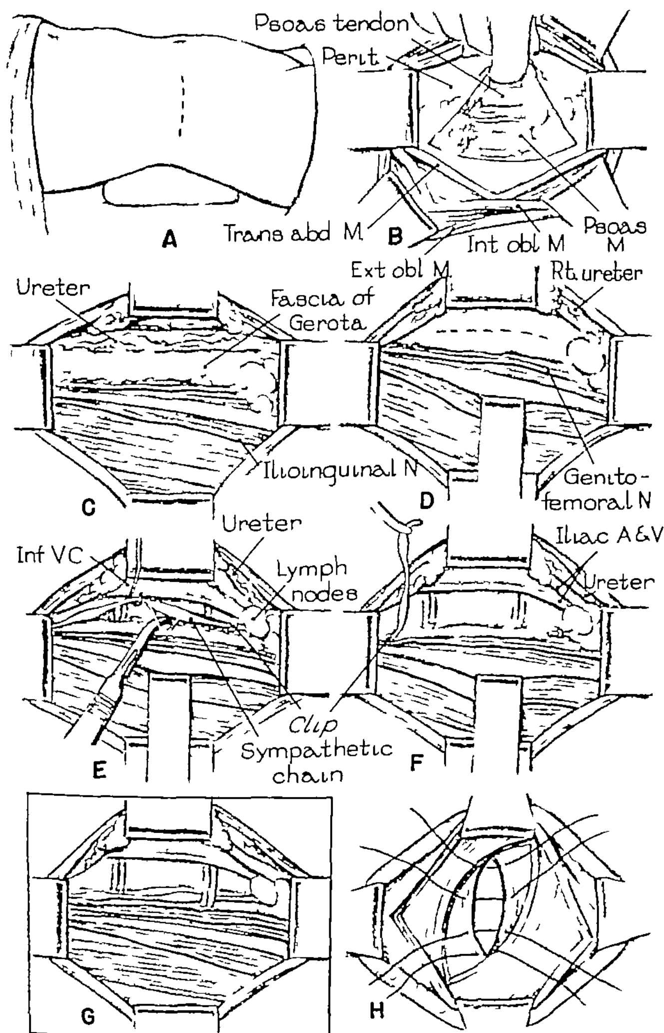
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Psoas tendon
Perit
Trans abd M
Psoas M
Int obl M
Ext obl M
Ureter
Fascia of Gerota
Rt ureter
Ilioinguinal N
Genito-femoral N
Ureter
Iliac A&V
Inf VC
Lymph nodes
Ureter
Clip
Sympathetic chain
A
B
C
D
E
F
G
H

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